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JOURNAL OF THE AMERICAN SOCIETY OF LUBRICATION ENGINEERS

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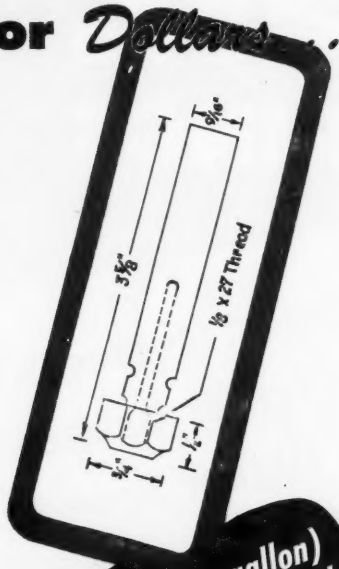

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Lubrication ENGINEERING

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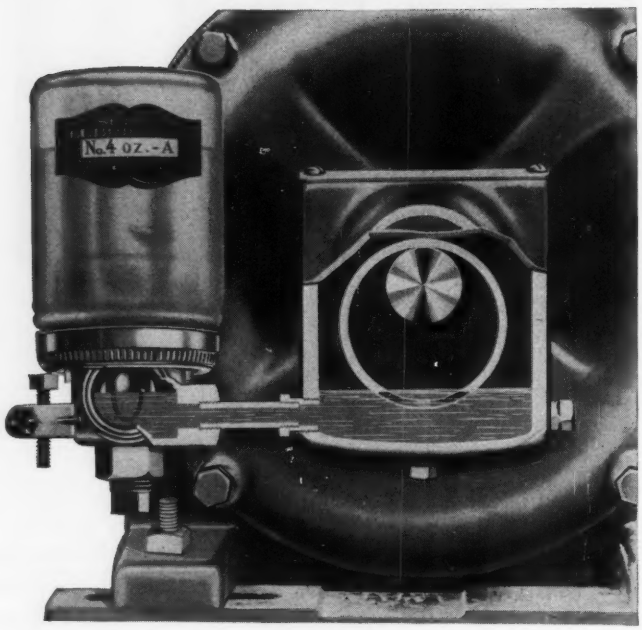
Prove it to yourself. Install one Acro Constant Level Lubricator and make your own comparison. Others have done this and ordered lubricators for additional machines, equipment, etc., and for new equipment as installed. Two such case histories are shown at the right. Write for free bulletin.



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9-26-49	174-4 oz. "
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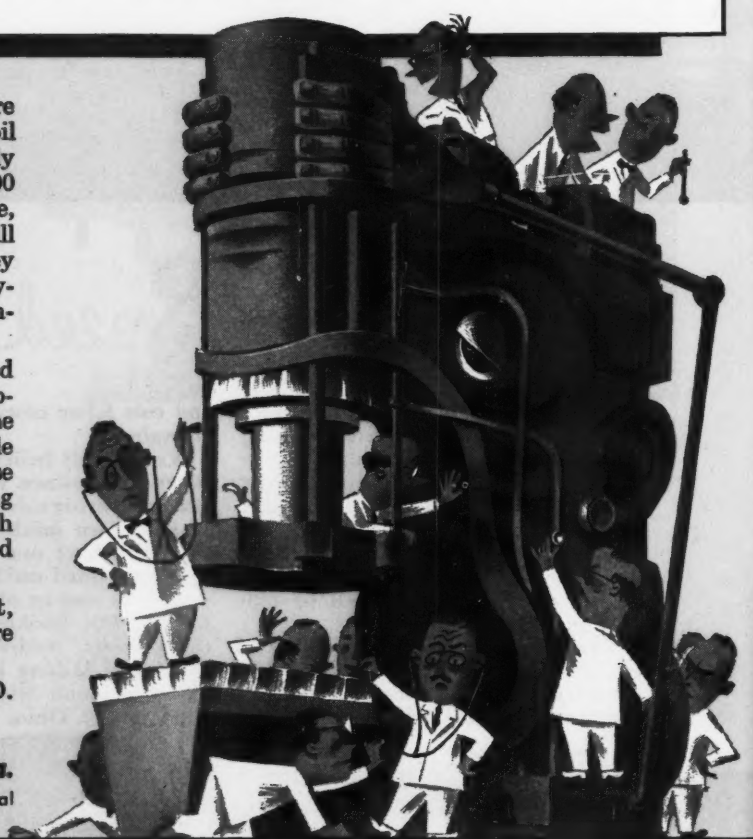

Reduced output and extra maintenance cost are the penalties when clogging occurs in the oil circulating system of machinery. But this costly production ill can be avoided. Sunvis H.D. 700 Oils *keep circulating systems clean*. What's more, if trouble exists now, Sunvis H.D. 700 Oils will *free oil lines and bearings of foreign matter*. They go to work immediately loosening up and carrying away any accumulation of dirt, carbon, water, or other contaminants.

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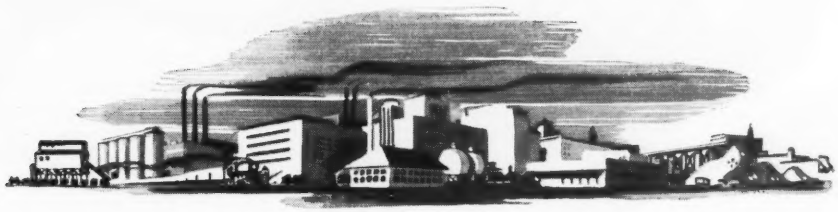

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In a material handling survey, lubricating of machines came in for its share of attention. The head of production called in an Alemite Lubrication Engineer to help him spot possible ways to cut costs. They found a way to lubricate machines that added 30 minutes more production daily. The total investment in Alemite equipment was $391.25! The saving in production time—in addition to a 60% reduction in lubricant used—comes to $2160 a year!

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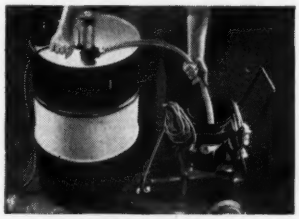

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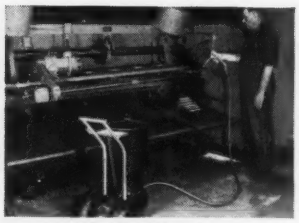

3. ***In Applying Lubricants . . .*** by saving up to 23.9 man hours for every 100 pounds of lubricant applied to bearings.

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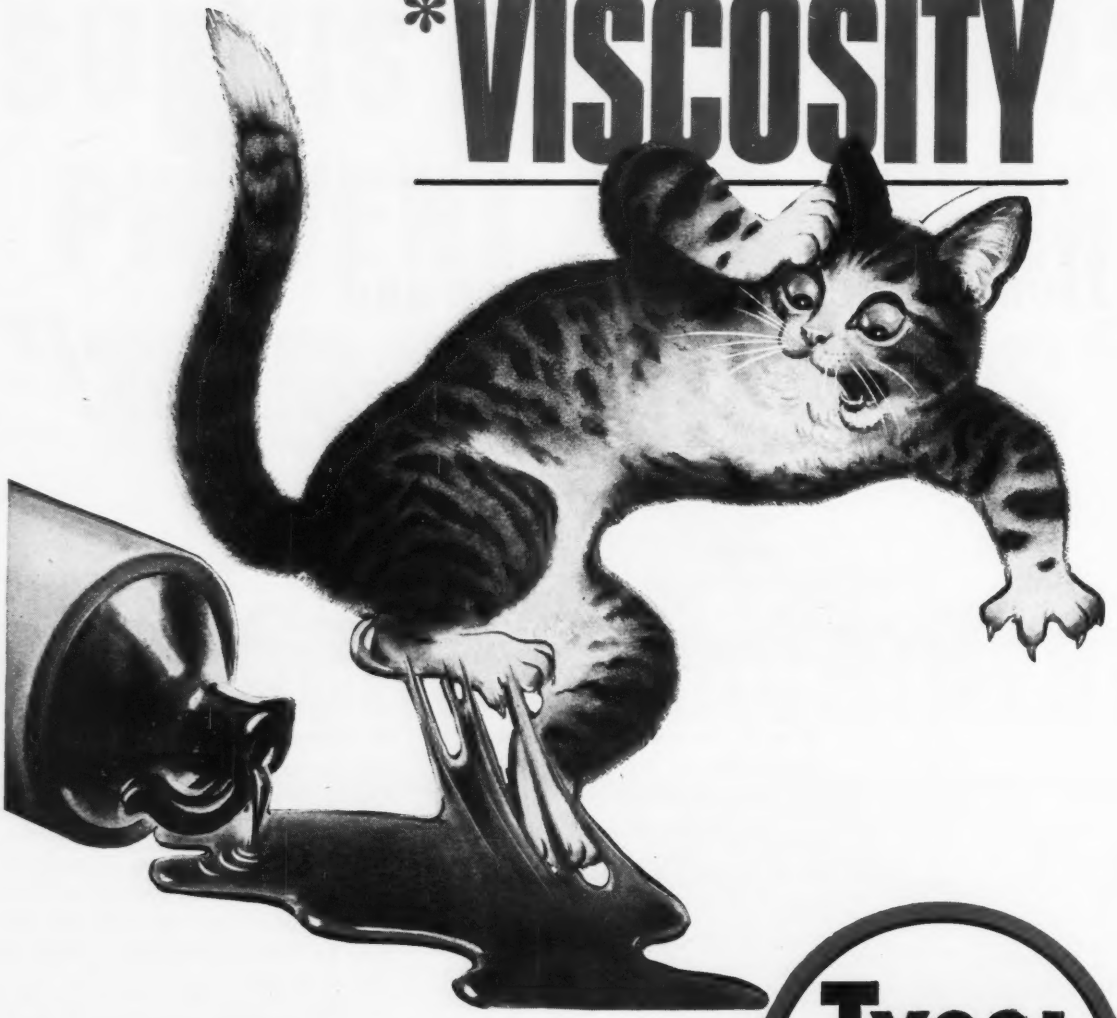

All equipment will last longer — give better service — if you use the proper lubricant. That's why you'll find it profitable to use Tycol high quality oils and greases.

There's a reason! No matter what your lubrication need — for roll neck bearings or mine cars, Diesels or high speed textile spindles, turbines, paper calenders or steam engines . . . where *VISCOSITY, penetration, extreme pressure is a factor — Tycol has a lubricant suited to your specific requirements.

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Lube Lines

Lubrication Engineers

It is interesting to observe the trend toward increased attention to lubrication theory and practice in the educational institutions, both here and abroad. Gradually, the need, which was slow in attaining recognition and responsive action, is being expressed by industry, through their search for trained personnel to administer the improved lubrication programs and processes, which are now in use. The importance of the proper lubricant, its scheduling and application to sustained, uninterrupted production, no longer ranks above the need for lubrication engineers, who are equipped not only with the physical tools, but who have the knowledge and education to meet the many problems that arise daily.

In a panel discussion, "Lubrication and Production," held at a recent Los Angeles Section meeting (see page 277), the necessity for lubrication engineers and the "upgrading" of the job of "oiling" was stressed. This is a further indication of the growing awareness of the vital role played by lubrication in modern industry. During the forum, a plea was made for greater attention to lubrication in machine design.

The Cooperative Journal Bearing Research Project, sponsored by ASLE, under the guidance of Dr. Dudley D. Fuller, Columbia University, was established to determine the extent of the existing bibliography relative to Journal Bearings. It is felt that this program of research will have as its ultimate result, a decisive effect on machine design.

In response to numerous inquiries, we are publishing the following list of universities where courses in Lubrication Engineering are available for the graduate chemical engineer or mechanical engineer:

1. Cornell University, College of Engineering, Ithaca, N. Y.
2. The University of Texas, College of Engineering, Austin, Tex.
3. Wayne University, College of Engineering, Detroit, Mich.
4. Massachusetts Institute of Technology, School of Engineering, Cambridge, Mass.
5. Northwestern University, The Technological Institute, Evanston, Ill.
6. Yale University, School of Engineering, New Haven, Conn.
7. Purdue University, College of Engineering, La Fayette, Ind.
8. Columbia University, School of Engineering, New York, N. Y.

In England, the Sir John Cass College of London has taken the lead in lubrication education, presenting a series of lectures by eminent authorities covering the subjects of petroleum engineering and the application of various petroleum products.

Massachusetts Institute of Technology, will, in 1951, conduct a two-week summer course on the theory and practice of lubrication. The series of studies will be open to any individual whose work interest lies in the field of lubrication. Since all lubrication engineering education is, at present, available only on the graduate level, this course was designed to include the man who has not attained an engineering degree.

Directed by Professor John T. Burwell, Jr. (M.I.T.), with the cooperation of ASLE; other members of the Society, noted specialists in their respective fields, will serve as lecturers.

While plans for this course are now in progress, full details cannot be announced at this time. As soon as available, this page will carry complete information.

Section Award

In the attempt to increase the ever-growing prestige and authority of the A.S.L.E. in the field of lubrication, an Awards Committee has been established in the New York Section. The function of this Committee under the Chairmanship of Mr. A. J. Zino, Jr., of Swan-Finch Oil Corp., is to judge the papers presented before the Section and select the individual who in their opinion, has delivered the best paper during the year.

It is hoped that the award will carry with it sufficient honor and credit to act as an incentive in the presentation of even more outstanding papers than those given in the past.

This indication of initiative and farsightedness on the part of the New York people leads us to believe we will have, for our readers, an even greater diversification of subject matter.

Educational Series

With the presentation of "Manufacture of Lubricating Oil," by C. M. Larson (Page 263), we are opening our series of practical articles in the field of lubrication. We are attempting, through this series, to render additional informative service to our readers as well as to provide a practical educational background in the training of industrial lubrication engineers.

The February, 1951 issue will present the subject of "Dispensing Equipment." Mr. Alex P. Fox, President, Lincoln Engineering Company, St. Louis, Mo., will cover the topic.

We strongly urge that this article and the ones to follow be clipped since the series will constitute a valuable reference file that will assist in solving shop problems and the proper selection and application of lubricants. Each succeeding issue will carry one article in the group.

LOAD, SPEED AND OPERATING TEMPERATURE OF ROLL NECK BEARINGS *

After graduation from Case School of Applied Science (now Case Institute of Technology), Mr. Hitchcock spent three years in graduate study at Carnegie Institute of Technology, conducting research work sponsored by a special research committee of ASME.
Since 1933 he has been affiliated with the Morgan Construction Company, where he was appointed Director of Research in 1946.

by J. H. Hitchcock
Director of Research
Morgan Construction Company
Worcester, Mass.

This paper reports the results of tests which have been made to measure the load, speed, and operating temperature of the oil-lubricated sleeve-type bearings which we manufacture for application to the roll necks of rolling mills. Tests have been made in a variety of installations, differing widely in size, and involving a wide range of operating conditions. Loads applied to the bearings were measured by means of gauge blocks equipped with resistance wire strain gauges. Temperatures were observed by thermocouples located within the bearing metal close to the bearing surface. The results obtained show the anticipated rise of temperature with increasing load and speed, and in a few cases suggest a reasonable correlation of temperature with load and speed. It is found, however, that the operating temperature differs considerably in different installations operating at equal load and speed, and can be changed appreciably in a single installation with constant load and speed by changing the viscosity or rate of flow of the lubricant. This emphasizes the fact that operating temperature depends upon many factors, and discourages determination of safe operating conditions in terms of load and speed alone.

Definition

For the benefit of those who may be unfamiliar with the application of bearings to roll necks, a brief description will serve to define the arrangement. A rolling mill resembles a clothes wringer, having two rolls geared together and driven at equal speed in opposite directions. The ends of the rolls, called roll necks, are carried in bearings which are supported by a housing having a vertical screw to adjust the opening between the rolls. Load is applied to the rolls by the resistance to deformation of the metal passing between them, and is transmitted through the bearings to the housing. In comparison to most other bearing applications, roll neck bearings are subjected to high loads and operate at relatively low speeds. In addition to these unfavorable conditions, roll neck bearings in most installations are exposed to a flood of coolant from the rolls carrying mill scale or other harmful material, so that considerable care is required in design and construction to achieve hydrodynamic lubrication.

Design of Roll Neck Bearings

In 1932 our company introduced a flood-lubricated, fully enclosed, sleeve type bearing to meet these requirements. This bearing was developed especially for application to the two-high continuous hot rolling mills which we have been building for the last sixty years, but has subsequently been applied successfully to almost all types of rolling mills.

In our bearings, the tapered roll neck is surrounded by a forged alloy steel sleeve having a tapered bore and ground to a mirror finish on its outer cylindrical surface. This sleeve is keyed to the roll neck and constitutes the journal of the bearing. The sleeve is carried in a steel bushing lined with cadmium-nickel bearing metal, centrifugally cast in place and finish bored to close tolerance and smooth surface. A cast steel chock equipped with oil passages and oil and water seals encloses the bearing assembly. The bearing is held on the roll neck by a locknut engaging a split threaded ring which lies in a groove in the roll neck. At one end of the roll a double acting ball or roller thrust bearing is mounted at the outer end of the sleeve to carry end thrust in either direction. No thrust bearing is required in the opposite bearing. Oil is introduced to the bearing at nominal pressure through an inlet hole and passages in the chock which communicate with radial holes at both sides of the bushing. These holes enter into oil pockets formed by shallow rebores at the sides of the bushing. A similar radial hole in one side of the bushing engages a lock screw passing through the chock to restrain the bushing against rotation. Oil discharged from the bearing surfaces is collected in drain channels at the ends of the chock near the bottom, and flows by gravity into the circulating system.

Lubrication

All bearings of our manufacture are lubricated with straight mineral oil supplied by a continuous circulating system including full filtration. The oil viscosity is specified for each installation to assure hydrodynamic lubrication under the prevailing conditions of load and speed. Because it is frequently necessary to specify high viscosity, and because contamination of the lubricant with water or other coolant is a constant hazard, the circulating system frequently includes a double compartment storage tank so that the oil in one compartment can be heated to assist water separation while the oil in the other compartment is in service. For the same reason, it is essential to employ oils of high demulsibility. In this connection it is important to pay a well-deserved tribute to the lubrication engineers who are responsible for the successful operation of these bearings in service. The gratifying performance of these bearings year after year would be utterly impossible without the attention and judgment exercised by the men who supervise their lubrication.

Operating Conditions

The range of conditions under which these bearings operate in service is quite wide. In the roughing end of a continuous rod mill, for example, speed may be as low as 6 rpm, with loads of 2000-2500 psi. In the finishing stand of a rod mill, normal speed exceeds 1500 rpm, and the loads are considerably lighter. In

*Paper presented at 5th Annual Convention of A.S.L.E., Detroit, April 11, 1950.

continuous two-high mills rolling flat sections such as skelp, the applied loads approach the nominal bearing rating of 3000 psi, at speeds ranging from 20 rpm at the roughing end to approximately 400 rpm in the finishing stand. There are several installations operating consistently at loads in excess of 5000 psi, these being low speed mills rotating at 11-25 rpm. In 4-high hot strip mills, bearing loads of 2000-2500 psi are common, with rotating speeds ranging from 20 to 200 rpm. The recent 4-high cold strip mills present one of the most interesting bearing problems. In such a mill the material is introduced with the rolls turning at low threading speed, and after threading has been completed the mill is accelerated rapidly to normal delivery speed of approximately 5000 fpm, corresponding to nearly 500 rpm on the backing rolls of the finishing stand. To assure hydrodynamic lubrication at threading speed requires a moderately high viscosity, which is not the optimum situation for operation at top speed. Nature solves this problem in part by raising the oil temperature during the period of high speed operation. This is an acceptable solution in existing mills, where the resulting bearing temperature is not excessive and where there is sufficient cooling capacity in the lubricating system to keep the temperature of oil entering the bearings at a level suitable for operation at threading speed. If the trend toward increasing rolling speed continues in future mills of this kind, other steps may be required to provide a more complete solution. Other interesting applications illustrating the wide range of utility of these bearings include mills rolling slabs, wide plates, blooms and non-ferrous metals such as brass strip and aluminum foil.

Experimental Equipment

In connection with an extensive program of research and development we have made a great many measurements of bearing temperature and load in our bearings under actual production conditions. In a few instances, we have also made such measurements in mills which were released temporarily from production, and which were operated for test purposes with the rolls forced against each other. In contrast to tests made during production, this arrangement permits variation of load, speed and oil supply at will, but the opportunity for making tests of this character naturally is extremely limited.

For measurement of bearing temperatures, six iron-constantan thermocouples were installed in the test bushings. Five of these were located in the loaded side of the bearing, one in the center and one near each end of the vertical center line, and two at the center of the bearing length on opposite sides of the vertical center line at points 8° 30′ distant from the vertical center line. One thermocouple was placed at the center of the unloaded side. The thermocouples were introduced from the outside of the bushing through small drilled holes terminating about .030 in. from the inner surface. The leads were laid in shallow grooves machined in the outer surface, and were covered with thin strips of bakelite lacquered in place. At the inner end of the bearing, the leads were collected and brought out through the oil drain hole. In most of the tests a single potentiometer was used for observation of temperature, with a battery of switches between the instrument and the respective thermocouple leads. In one series of tests a Leeds & Northrup multi-point recorder was used to obtain a continuous record of bearing temperature.

Special gauge blocks were designed and built for measurement of bearing loads. Each block is a cube of heat treated alloy steel with a resistance wire strain gauge permanently cemented to each vertical face. Each strain gauge is surrounded by a thick rubber gasket cemented to the block, and a thin metal cover is cemented to the gasket and secured to the block by screws passing through the gasket. This arrangement protects the strain gauges from water, moisture vapor, and mechanical damage. The four strain gauges are connected in series, with leads passing through the gaskets. Temperature compensation is provided by cementing four identical strain gauges to a separate block, similarly provided with gaskets and metal covers, and placing the compensating block in a location where it is subjected to the same ambient temperature as the gauge blocks. Four gauge blocks were constructed, two rated at 350,000 pounds each, and two rated at 2,000,000 pounds each. Each block was calibrated in a testing machine, and all were found to be accurate to a high degree, even with moderately eccentric loading.

In service, two gauge blocks are installed between the top bearing chocks and the housing screws, so that the load applied to each bearing is transmitted through the gauge block to the screw. If it is necessary to operate the housing screws while the bearings are loaded, as is the case in many mills, some form of restraint is required to protect the gauge blocks from torsional stresses. For this purpose the gauge block is enclosed in a two piece housing, the lower half of which is fitted tightly into a slot in the bearing chock, and is keyed to the upper half. Thus torque resulting from rotation of the screw is transmitted into the bearing chock, leaving the gauge block free of torsion and subject only to vertical load.

A Baldwin-Southwark type K indicator was used for observation of loads sustained at reasonably constant values. This is essentially a Wheatstone bridge circuit with electronic amplification, having the strain gauges on one gauge block in one leg of the bridge and the strain gauges on the compensating block in the adjacent leg. By slight modification of the type K indicator, a General Electric photoelectric recorder could be connected at will to provide a continuous record of load, and to record loads of transient character. Only one gauge block could be connected to the indicator at a time, and switches were provided to facilitate quick transfer from one to the other.

The principles which determine the operating temperature of a bearing running under hydrodynamic conditions are well known and need not be stated here in detail. Let it suffice to say that nature strives to produce a temperature at which the rates of heat generation and heat dissipation are equal, and that this temperature will be reached if conditions remain constant for a suitable length of time. The steady state temperature obviously is affected by any factor which has an influence on the generation or dissipation of heat. Unfortunately too little is known about the quantitative behavior of these factors to permit analytical evaluation of bearing temperature, so that at present experimental observation is the only feasible method of approach.

Experimental Results

In reporting our experimental observations of bearing temperature, the point of first interest undoubtedly is the pattern of steady-state temperature at the six thermocouple positions under various operating conditions. The following observations were made on a bearing 17¼ in. diameter by 13¾ in. long, operating at loads

ranging from 850 to 1700 psi and at surface speeds varying from 1400 to 2500 fpm. The bearing was lubricated with oil having a viscosity of 620 SSU supplied at a rate of 4.5-6 gpm per bearing, depending upon speed. Oil was metered to each bearing through an orifice, with an inlet pressure of 13.5 to 15 psi on the upstream side of the orifice. Oil inlet temperature varied from 94 to 104 F. In general, there is little difference in temperature between the three points at the center of the bearing length, although the point on the trailing side of the vertical center line is in most cases a few degrees warmer than the other two. The two ends of the bearing, as should be expected, are almost always considerably cooler than the center, but the inboard end adjacent to the roll is often appreciably hotter than the other end, presumably because of imperfect alignment of the chock with the deflected roll neck. The temperature on the unloaded side of the bearing is consistently low, reaching only 20 degrees above the oil inlet temperature even when the highest temperatures were reached in the loaded side.

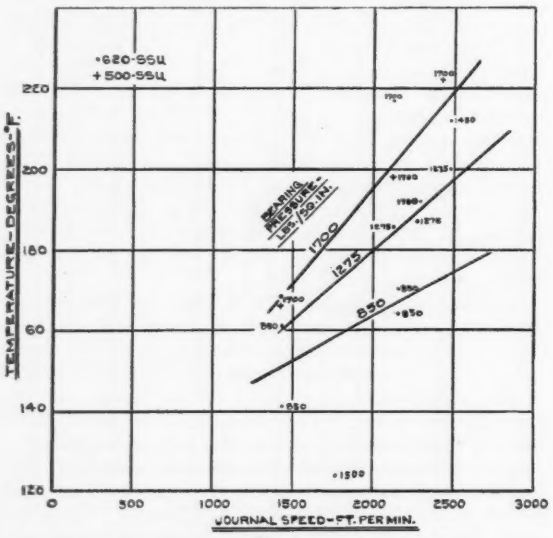

Fig. 1
Observed temperature in terms of load and speed.

These observations were made under test conditions, in a mill which was released from production for the purpose, so that loads and speeds could be varied at will. The highest temperature observed under each condition was plotted against journal speed, in an effort to establish correlation between temperature, speed and load. The result is shown in Fig. 1, where the number beside each point represents the bearing load in psi. Here two sets of tests are represented, one employing the 620 SSU lubricant mentioned above, and the other using oil of 500 SSU viscosity for a brief run at one value of load. This change of viscosity appears to have made no marked change in maximum temperature, but was accompanied by an increase in oil flow to 5.3 to 7.1 gpm which presumably offset the change in viscosity. Despite the spread between separate observations under ostensibly equal conditions, the trend of rising temperature with increasing load is shown clearly.

As a matter of curiosity, the same data used in this illustration were plotted in terms of that rule of thumb factor called PV which is sometimes suggested to define the limits of successful bearing operation from the standpoint of temperature. This is the product of load in pounds per square inch by surface speed in feet per

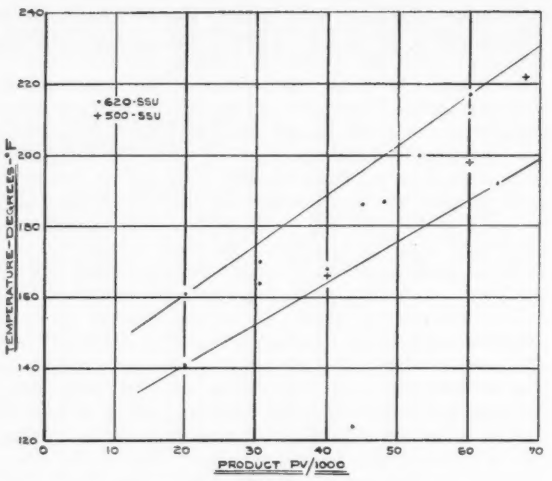

Fig. 2
Temperature vs. PV, 17¼ in. by 13¾ in. bearing.

second, and would be an adequate measure of the rate of heat generation if the coefficient of friction were constant. This graph is shown in Fig. 2. Naturally the results show rising temperature with increasing values of the PV factor. This is just another way of saying that the more rapidly heat is generated in a bearing the hotter it will become. The fallacy in using this factor as a criticism of safe operating conditions is two-fold: first, it excludes variation of the coefficient of friction, and second, it ignores differences in the heat dissipating capacity. In a bearing which approaches or exceeds its safe operating temperature, a moderate change in viscosity, oil temperature, rate of oil flow, or in the conditions surrounding the bearing can make the difference between successful operation and failure, irrespective of the PV value. Comparison between different bearings on the basis of the PV value is still more misleading, because of the wide variations in heat dissipating capacity which may exist.

The excellent experimental work done at the Engineering Experiment Station at Annapolis† provides a significant comparison in this regard. Fig. 3 contains a plot of maximum temperatures observed in a bearing 6 in. diameter x 5 in. long tested at loads up to 1000 psi and speeds up to 10,000 rpm, lubricated with oil having a viscosity of 193 SSU at the inlet temperature of 130 F. It will be observed that the relation between temperature and PV is different for each value of applied load. If the maximum safe temperature were 220 F., for example, the limiting value of PV for this particular bearing would be about 7300 for a load of 25 psi and about 105,000 for a load of 1000 psi. Obviously determination of safe operating conditions with a constant value of PV is absurd even in this single bearing.

It is pertinent to compare our observations of bearing temperature with those reported at Annapolis. The curves of Fig. 1 are reproduced in Fig. 4, together with the corresponding observations from Annapolis for the 6 in. x 5 in. bearing previously described. By coincidence, the maximum speed in our test was nearly equal to the minimum speed in the test at Annapolis. Despite the differences in dimensions and operating conditions, the two sets of data agree remarkably well.

Another series of tests was made later, with the same size of bearings described above, but with the rate of oil flow increased to 10-13 gpm per bearing. The

†EES report C-3041-F, 25 February 1949.

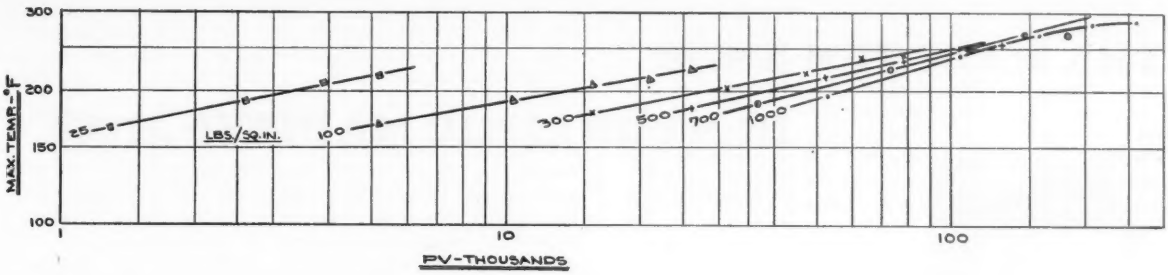

Fig. 3

Temperature vs. PV, 6 in. by 5 in. bearing, Annapolis.

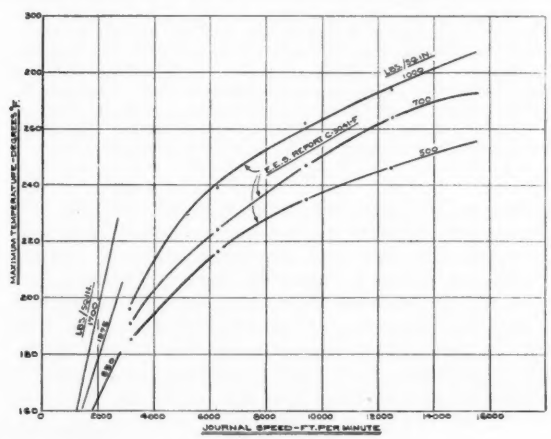

Fig. 4

Comparison of observed temperatures.

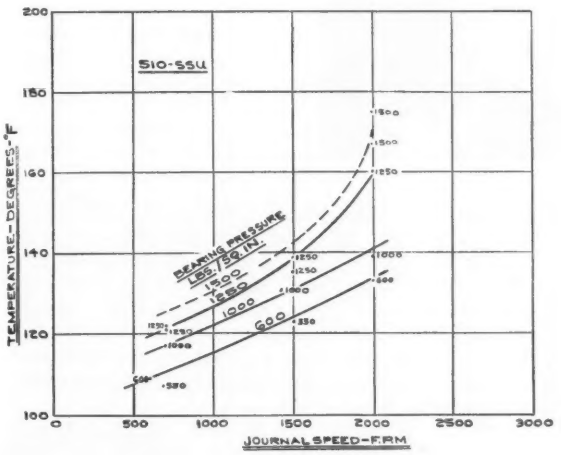

Fig. 5

Temperature with increased oil flow.

results of these tests, shown in Fig. 5, demonstrate that the increase of oil flow caused a temperature drop of approximately 20 degrees in comparison to the previous tests under conditions which apparently were equivalent in other respects.

In the course of our work on this subject, we have had opportunity on a few occasions to observe the variations of bearing temperature during failure. By increasing load or speed or both in small increments and allowing sufficient time at each step to reach steady state temperature, it is possible to produce a critical state in which failure is imminent. In this state a bearing may operate for a prolonged period without distress and without significant change of temperature, but obviously it requires only the most trivial mishap to initiate failure. The beginning of failure is marked by an abrupt temperature rise of a few hundred degrees at some point of the bearing. This localized high temperature persists for a short time, then drops almost as abruptly as it rose, returning approximately to its normal level. While this temperature drop occurs, a similar sudden rise of temperature occurs elsewhere in the bearing, usually at a point adjacent to the first location, and the same pattern is repeated. As the second hot spot cools off, a third one develops, either in the first location or elsewhere, and this too may cool off before failure becomes complete. This type of failure, when complete, is characterized by uniformly high temperature throughout the loaded side of the bearing, resulting in the large scale flow of bearing metal which we call wiping.

Examination of bushings which have failed while operating in the critical state described suggests the following mechanism of failure. The hardness and shear strength of the bearing metal have been reduced appreciably by the rise in temperature, and the oil film undoubtedly is extremely thin, so that even a slight departure from perfect conditions can lead to rupture of the oil film and distortion or flow of bearing metal at the point of rupture. This causes a sharp rise in temperature at the zone of distress and allows the bearing metal in this zone to flow more freely, and to assume a position which permits re-establishment of hydrodynamic lubrication. This is followed by a temperature drop which soon stops the migration of bearing metal, leaving irregularities in the bearing surface on one side or both of the zone of flow. These irregularities then penetrate the thin oil film and produce a new zone of local heating and flow, with the same result as before. This critical state may be sustained for a considerable length of time without catastrophic failure. In one instance which we observed, operation was continued for twenty minutes with repeated transfer of local heating from one part of the bearing to another. Even at the end of that period when the mill was stopped, the failure was not completely catastrophic, wiping having occurred only in certain localized areas.

Conclusions

These results are presented not with any thought that they represent a complete picture, but with the hope that they will be interesting and useful to those who are concerned with this subject. The conclusions are self-evident that there is a correlation between temperature, load, and speed for a particular bearing under conditions which are constant in other respects, and that load and speed alone do not form an adequate criterion of safe operation.

THE MAIN TEN ENDS

IN HYDRAULIC MAINTENANCE *

by M. A. Hayden
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Mr. Hayden obtained his Bachelor of Electrical Engineering Degree from the Engineering College at the University of Detroit. He joined the Engineering Department of Vickers, Inc., in 1935 and has served as Application Engineer, Sales Engineer and District Manager of the Cincinnati and Atlanta offices. In 1948, Mr. Hayden was appointed Assistant Manager of the Industrial Sales Division, and in September, 1950, was made General Sales Manager of Waterbury Tool Div. of Vickers, Inc., Waterbury, Conn. Mr. Hayden is a member of the Society of Automotive Engineers, the Engineering Society of Detroit and Detroit Sales Executive Club.

At a recent Plant Maintenance Conference in Cleveland it was pointed out that last year American industry spent over 8.6 billion dollars on maintenance. That may not seem like a large figure today but it is an amount greater than industry's total net profit in 1929. Mr. J. E. Sutherland of MacDonald Brothers, Inc., reported to the Conference, based on a survey of 935 manufacturers, that the average plant maintenance costs were more than 40% of net profit.

These figures cover only the cost of maintenance operations that actually took place. They do not take into account lost production costs, or the additional costs of neglected maintenance and poor maintenance methods in accidents, down time, machine wear, excess labor charges, etc. These costs are less tangible perhaps, but they undoubtedly total to a much larger figure than 8.6 billion dollars.

Today, many managers are making detailed surveys to find out what factors boost maintenance charges and where savings may be made. It is hoped that they do not lose sight of the fact that their primary goal should not be to reduce costs in the maintenance department, but to reduce breakdown costs in lost production.

High maintenance costs and lost production costs are being attacked in a variety of ways. Better planning and scheduling cuts manpower waste and helps stop trouble before it starts. As Lyman A. Darling of DuPont has said, "Planned maintenance is almost certain to be economical maintenance. Hit or miss methods are almost always costly."

Mr. H. A. Zannoth of Cadillac Motor, recently stated in an S.A.E. sponsored panel on Preventive Maintenance of Plant Equipment that Cadillac has reduced breakdown time 83% over a period of five years through preventive maintenance. He said that at the start of their program the maintenance group was divided so that approximately 75% were assigned to preventive maintenance while the remaining 25% were used for breakdowns. At the end of one year he was able to reduce his preventive maintenance group by 5% and his breakdown group by 50%.

Machine Tool Editor Guy Hubbard says high labor costs as compared to lower costs of mechanical manufacturing and assembly operations are making it increasingly unprofitable to have things repaired. He hints that we may see an increasing number of sub-assembly machinery details made up in packaged units. You will throw away the entire unit and install a new one instead of calling in a man to repair the damaged part.

These observations about maintenance in general are made by men who are authorities in their field. This paper is primarily concerned with hydraulic maintenance. Although this is only a small factor in the overall maintenance picture, it is an important factor to most of us. If you are interested in reducing lost production costs on your hydraulically operated machines, here is a plan which can help you.

This plan is not original. It is a combination of the best hydraulic maintenance practices that have been used successfully in various plants. No companies are known to use all the points of this plan, but many are using parts of it and have been able to reduce lost production costs on hydraulically operated machines. Some have also been able to reduce the cost of their hydraulic maintenance.

This plan recognizes that maintenance will always be necessary, and that breakdowns can occur in spite of the best maintenance. Its purpose is to reduce the number of breakdowns and their duration, and thereby keep lost production costs to a minimum. It may or may not reduce your hydraulic maintenance costs, depending on your particular circumstances; in fact, it might increase the maintenance costs of some companies. But if the cost of the plan is less than the amount it saves in lost production, it is a good investment for your company.

This plan embodies ten ends or aims which are grouped as "The Main Ten Ends of Hydraulic Maintenance."

END No. 1

Recognize that the user of hydraulic machinery can have more control over hydraulic maintenance than either the machinery builder or the hydraulic equipment manufacturer. Use this control effectively to reduce down time on your hydraulic machines.

You may dispute this point and say that the machinery builder and the hydraulic equipment manufacturer have more control over hydraulic maintenance than the user. From your standpoint that may be true, but it need not be true. As the user, you are the customer.

* Paper presented at 5th Annual Convention of A.S.L.E., Detroit, April 11, 1950.

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As the customer, you can specify and buy what you want—provided you are willing to pay what it costs—and you should be willing to pay any extra cost you can more than recover in reduced lost production time or reduced maintenance costs.

Perhaps this point would be clearer if we try to define the responsibilities of the hydraulic equipment manufacturer, the machinery builder and the user, as far as a hydraulically operated machine is concerned.

The manufacturer of the hydraulic equipment should provide adequate design, good workmanship and conservative rating in the hydraulic units. Usually the hydraulic equipment builder has little control over the circuit in which the hydraulic equipment is used or the manner in which the units are applied or piped, even though he often makes recommendations concerning the hydraulic circuit. He also has little control over how the user cares for the hydraulic equipment. His responsibility is usually confined, therefore, to the correct functioning of the hydraulic units as units. And he protects the user as well as the machinery builder on this point by his warranty or guarantee.

The machinery builder is responsible for combining individual hydraulic units into a hydraulic circuit which meets the operating requirements of the machine, for mounting and piping the hydraulic units properly, and for locating them so that they are accessible for adjustments and maintenance. The user sometimes is critical of the machinery builder on four counts:

1. Failure to take into account all of the requirements when making up the hydraulic circuit.
2. Improper application of hydraulic units or requiring them to operate outside of recommended limits in order to do the job.
3. Inferior workmanship in mounting and piping of hydraulic units.
4. Insufficient protection from dirt and overheating, particularly in reservoir design.

On these points the machinery builder usually protects the user by warranty or guarantee.

Service problems arising from causes for which either the hydraulic equipment manufacturer or the machine manufacturer is responsible usually show up when the machine is installed, and can be corrected by the manufacturer responsible. From the machine user's standpoint, it can be assumed that his responsibility starts when it has been demonstrated that the machine performs as required when new. His problem is then to maintain that satisfactory performance.

The user is responsible for accurately specifying what he wants in a hydraulic machine, using a good hydraulic oil, operating the hydraulic system within its limitations, and using qualified people to systematically maintain the hydraulic equipment.

If there is still any doubt about the user's control of maintenance problems, here are the results of a recent analysis of service calls to customer's plants on hydraulic equipment, and of unit repairs. It shows the following approximate distribution of causes for such service:

70% due to improper condition of the hydraulic oil.

10% due to improper diagnosis of the trouble or lack of "know how" in making repairs.

10% due to mechanical failures such as bearing failures from misalignment, seal failures due to dirt, etc.

5% due to operating units beyond recommended limits on speed, pressure or volume.

5% due to miscellaneous unclassified causes ranging from excessive packing friction on hydraulic rams to chatter resulting from inadequate way lubrication.

Assuming that a hydraulic machine has been demonstrated as satisfactory when delivered, and has operated satisfactorily through its warranty or guarantee period, the evidence of this analysis points to this conclusion: 95% of the service problems on hydraulic equipment are within the control of the user. Only 5% should give rise to service problems which cannot be handled by the user.

Several large automotive companies recognized "End No. 1" when they started the Joint Industry Conferences on the machinery they buy and its principal components. The J.I.C. Committee Meetings on hydraulics were attended by machine tool builders and hydraulic equipment manufacturers in addition to users. The purpose of these meetings was to set up minimum standards which, when specified by the buyer, would assure the user a reasonably satisfactory machine from the standpoints of both operation and maintenance.

The recommendations of the J.I.C. Committee on hydraulics are based chiefly on maintenance considerations. They include some restrictions on hydraulic units proper, but are mostly concerned with the manner in which the hydraulic units are incorporated into the machine tool. They stress such factors as safety, accessibility, reasonable oil temperature, the separation of the power unit from the machine, and the use of gasket mounted valves with sub-plates which permit permanent piping and make possible control cabinets for hydraulic equipment similar to electrical control cabinets.

The recommendations of the J.I.C. Committee on hydraulics are available to you. If you will use them in making up specifications for new machines you buy, you will be taking the first step in controlling your hydraulic maintenance problems.

Recognize the fact that the user of hydraulic machinery can have more control over hydraulic maintenance than either the machinery builder or the hydraulic equipment manufacturer. Use this control effectively to reduce down time on your hydraulic machines.

END No. 2

Standardize on one make of hydraulic equipment for all hydraulic machines in your plant.

Stated by the representative of a hydraulic equipment manufacturer, this point may sound prejudiced. If it does, remember this: This point did not originate with a hydraulic equipment manufacturer; it is a practice being adopted by more and more users because its soundness is supported by several good reasons:

1. In hydraulic equipment there is practically no interchangeability between either units or parts of different manufacturers. Having several makes of hydraulic equipment in your plant to service and stock for is therefore a handicap rather than an advantage. The old rule of two or more sources of supply is rarely a good practice where there is no interchangeability.
2. If you confine your hydraulic equipment to one make, you get better maintenance. Your maintenance men, instead of being limited to a little knowledge about a lot of makes of hydraulic equipment can acquire a better working knowledge of one make.
3. You improve your inventory of spares and parts. From one standpoint, you can reduce your inventory if you stock only one make, or from another standpoint, you can keep your same inventory value, and stock more widely on one make than you would be able to for several.

4. You centralize responsibility for hydraulic equipment on your machines when you standardize on one supplier. When your own maintenance men are unable to repair a machine, and you must call in an outside service representative, it is important to you that responsibility be undivided.

Your selection of the hydraulic equipment on which you standardize should take these points into account:

1. Make your selection on the basis of quality rather than initial cost. A few dollars saved on the initial cost of a hydraulic unit may later cost you many times the savings in added maintenance costs or lost production costs. The best hydraulic units are not necessarily the most expensive, but neither are they always the least expensive, so selection should be made on the basis of quality, according to your or other's experience, rather than price.
2. Select a source whose line of hydraulic equipment is wide enough to meet all of your needs.
3. Select a source whose developments in hydraulic equipment are apt to keep abreast or ahead of the field, in the long run.
4. Select the source which can best take care of your emergency requirements on service, repairs, replacements and engineering.

In putting standardization into practice, be sure you specify the make of hydraulic equipment on every machine you buy. Many users leave this up to the machinery manufacturer. In those cases, if first cost of the machine is an important consideration, the competitive situation may cause your machinery builder to use hydraulic equipment of various manufacturers on a price basis alone. The amount he saves you will be small at best, and you may have to spend the savings several times over in maintenance and added inventory cost on spare units if the equipment is not up to standard. In general, it will pay you to specify the best hydraulic equipment obtainable.

Standardize on one make of hydraulic equipment for all hydraulic machines in your plant.

END No. 3

Maintain a stock of spare hydraulic units and parts.

While this seems to be an obvious point, quite a few users do not follow it. Or if they do, it is to such a minor degree that they do not get much benefit from it.

Hydraulic equipment manufacturers for the most part do not object to stocking the standard units and parts you use. However, that is of little advantage to you because even if they can ship immediately on your emergency orders, your lost production costs go on until you actually receive the shipment. In addition there are always the dangers of mistakes on the order, lost shipments, or the parts not being immediately available, to increase your down time. When your own stock includes what you need to take care of a breakdown, you save down time, and your savings in lost production costs will often pay for your investment in the inventory required to do this. It is both good insurance and good economy to carry your own stock of replacement units and parts. And it is especially practical when a user standardizes on one make of hydraulic equipment. Your hydraulic equipment manufacturer will help you determine what stock you should carry, based on the needs of your plant.

Maintain a stock of spare hydraulic units and parts.

END No. 4

Before you buy a hydraulic machine, check to make certain it will meet your production requirements *and* your maintenance requirements.

When you buy a machine you are buying production but you are also buying maintenance. The proportion of each you receive depends mostly on you. The machine tool builder and the hydraulic equipment manufacturer both want your business. They will give you the best they can for the initial price you are willing to pay. So if you buy on initial price alone, you may buy a higher percentage of maintenance cost than you expected. You should buy on initial cost plus maintenance cost.

It is important that you check to make sure a machine meets your production requirements. Many problems on new machines are maintenance problems only in the sense that changes are necessary to meet operating requirements that were not taken into account when the hydraulic circuit was designed. While this situation doesn't occur frequently, it is good practice for you to insist on checking hydraulic circuits for your machine to make sure they meet your operating requirements. Only a few companies are doing this at present, but those who are, consider it important both for the protection it gives them from mistakes, and for the opportunity it provides them for reviewing the circuit from a maintenance standpoint.

It is most important that you check to make sure a machine meets your maintenance requirements. Those few companies who give their maintenance department an opportunity to check a machine while maintenance considerations can still be taken into account, often benefit greatly. The experience of your maintenance group can be a valuable asset to you in setting up your specifications on new machines.

Good maintenance begins when you first start thinking about a new machine. Then is the best time to take your hydraulic maintenance problems into consideration. Use the experience of your own hydraulic maintenance group, the recommendations of the J.I.C. Committee on hydraulics, and the advice of your hydraulic equipment supplier. This practice will sometimes result in a machine costing you more money. But if the additional cost is minor relative to the protection you have bought against lost production costs and maintenance—as it usually is—you have invested wisely.

Before you buy a hydraulic machine, check to make certain it will meet your production requirements *and* your maintenance requirements.

END No. 5

Use the best hydraulic oil you can obtain for your machine, keep it in good condition, and change it as often as necessary.

The most significant of the figures given in the analysis under "End No. 1" is the first. It indicates that 70% of the causes for hydraulic service can be traced to the condition of the hydraulic oil. This 70% can be broken down to include:

1. Excessive wear due to dirty and abrasive oil.
2. Improper type of oil.
3. Rust resulting from condensation or from using an oil with high water affinity.
4. Lacquer deposits and sludge resulting from chemical or physical changes in the oil in continued use.
5. Lint, the presence of which in some hydraulic oils is an undesirable result of the manufacturing process. When suction filters are used, they usually remove lint, but in so doing they often plug to the point of

cavitation. When suction filters are not used, lint usually accumulates at points of restriction in the hydraulic circuit, and plugs units such as flow controls.

The principal factors in oil contamination are:

1. Foreign particles (grit, dust, etc.) drawn through unprotected air vents or air leaks in the reservoir, or through cylinder rod packings.
2. Metal particles, deteriorated paint or sealing compounds from within the circuit.
3. Physical and chemical changes in the hydraulic oil resulting from long use or from extreme operating conditions.

These points emphasize the need for using the proper oil initially, using a dirt tight reservoir with an air filter and an oil filter, and changing the hydraulic oil when necessary.

Operate your hydraulic machines on the best quality oil you can obtain for them, regardless of price. Most hydraulic equipment manufacturers do not recommend a specific brand and type of hydraulic oil because there is probably no single make and type of oil which is the best for all makes of hydraulic equipment, or for all types of applications. Different hydraulic equipment and different operating conditions may call for different types of hydraulic oil. Most hydraulic equipment manufacturers do put out specification sheets covering a range of physical properties of oils which, in general, are suitable for use in their equipment. These specifications as a rule are sufficiently broad to admit at least one oil from each major oil company. But oils which come within these specifications are not necessarily suited equally to your particular conditions. Beyond these specification sheets most hydraulic equipment manufacturers, because they are not oil specialists, depend on the oil company representative to recommend the best oil for your particular application.

It usually pays to standardize on your oil supplier also. Pick an oil supplier in whom you have confidence and follow his advice on hydraulic oil. Here again, a few dollars saved on the initial cost of oil may be false economy.

Some companies purposely buy the cheapest hydraulic oils they can because they lose a percentage of it through leaks. It is usually more economical in the long run to repair the leaks and use good hydraulic oil.

In any maintenance program, principal attention should be given to the hydraulic oil. The proper hydraulic oil should be used in the machine initially. If a lint free oil is not used, the suction filters should be removed after the first forty-eight hours of operation and cleaned of lint. Any oil, even new oil, should be filtered before being placed in the hydraulic system. Most new hydraulic oil is clean, but filtering is advisable because of the possibility of contamination from bulk handling of hydraulic oil and the re-use of old drums.

The hydraulic oil should be maintained in proper condition in use. The condition of the oil should be checked frequently. If it is necessary to add oil, only clean oil of the proper grade should be used. The oil should be changed or renewed whenever it shows signs of deterioration. The hydraulic system should be flushed whenever sludge is present or laquering appears, and refilled with new oil of the proper type. A number of good flushing oils are available and should be used according to the instructions of the manufacturer. In no case should flushing oil be left in the system indefinitely.

Use the best hydraulic oil you can obtain for your machine, keep it in good condition, and change it as often as necessary.

END No. 6

Instruct the machine operator on the functions and limitations of the hydraulic equipment on his machine.

Most machine operators are not told much about the manner in which their hydraulic machine functions, or the limitations of the hydraulic equipment. Yet they usually manage to learn a little about it by observation, experiment or hearsay. It does not take them long to find out they can get out their production sooner and make their job easier by setting up the feed rates on the hydraulic flow controls, or that they can go longer between tool sharpenings by setting up the pressure on hydraulic pressure controls so that the tools cut when dull. Such examples show that a little knowledge can be a dangerous thing. Increasing pressure and flow settings on hydraulic valves may be dangerous not only to the hydraulic units themselves, but may also damage the machine or tools as well.

If you are unable to control tampering with hydraulic adjustments by your machine operators, you should take steps to protect your equipment. The J.I.C. Committee on hydraulics recommends that you lock or seal all hydraulic adjustments after they are properly set. To permit you to do this, the adjustable hydraulic units should either be provided originally with a means for locking or sealing, or be grouped in an enclosure which can be locked.

Some companies make it a practice to see that the operator of a new machine understands the function and limitations of his hydraulic equipment. They try to build the sense of pride which an operator often has in his machine. The better understanding this gives the operator of his equipment—what it is supposed to do and what it is not supposed to do—will help him cooperate with you by reporting minor troubles before they become serious or before breakdowns occur. Many hydraulic difficulties occur gradually rather than suddenly, and give ample warning if anyone is alert enough to detect them. The machine operator is in the best position to notice such conditions, and you can take advantage of this.

Instruct the machine operator on the functions and limitations of the hydraulic equipment on his machine.

END No. 7

Select good men for your hydraulic maintenance and train them as specialists.

Many users handicap themselves in maintaining satisfactory operation of their hydraulic machines by failure to use trained men for hydraulic service. Lack of "know how" often results in more damage than repair.

You should see that all of your hydraulic maintenance is handled by specialized men who are given the necessary training in the fundamentals of hydraulics and proper maintenance procedure. The necessity for specialized maintenance men for electrical and other repair work has been recognized. And the same necessity must be recognized in properly maintaining hydraulic equipment. Too frequently, an electrician, a pipe fitter or a general repair man, who has no training in hydraulic equipment, is given the job of maintaining and repairing hydraulic units.

High pressure hydraulic equipment is precision equipment in every sense. The difference between an

automobile pump at 60 PSI and a machine tool pump at 1000 PSI is not so much in principle but in the precision of design and manufacture.

Any one charged with maintaining hydraulic equipment should be familiar not only with the functions of the hydraulic units, but also with the degree of precision which must be retained in hydraulic equipment if it is to give satisfactory performance.

In maintaining hydraulic equipment at least three points must be respected: clearances, alignment and cleanliness.

In all hydraulic units there are internal oil passages subject to various pressures. Usually a single hydraulic unit has some passages carrying oil at pump pressure, some at reservoir pressure and some at working pressure. Also, in most hydraulic units, one part is required to move within another, such as a valve spool within a valve bore—the purpose being to interconnect the internal passages in various ways for various results. It is necessary that these internal passages be sealed from one another. Packings or oil seals cannot usually be used for this purpose for mechanical reasons. Sealing is therefore usually accomplished by the fit of the valve spool to the valve bore—by making the clearances as small as possible while still permitting free movement of the spool in its bore. Such clearances may be in the range of .0002" to .0006" and it is necessary that these clearances be maintained in use for satisfactory operation. Dirt, chips, sludge and laquer deposits change these clearances, causing excessive internal leakage or sticking.

Where clearances must be so close and internal bores are relatively long, anything which can cause warpage can result in binding of valve parts. Such warpage can occur from deflection of valve bodies due to internal pressure, from unequal expansion due to heating, or from twisting which results when the unit is mounted on a surface which is not flat. Overzealous use of a pipe wrench on a heavy pipe which is not properly lined up with a unit can also result in binding. A deflection of only a few tenths is often all that is necessary to cause trouble.

Whether sticking is due to foreign material, or binding results from warpage, the answer is not to machine a few thousandths off the parts to restore free movement. Yet this is sometimes done.

Cleanliness and carefulness are most important when dismantling hydraulic units, handling the internal parts and reassembling. Where clearances are so close, even a slight burr or nick, or a small piece of dirt or lint, may interfere with the correct functioning of a unit.

Your maintenance men can be trained in the "know how" of hydraulics. A great deal of educational material on hydraulic equipment has become available, in addition to the published information by hydraulic equipment manufacturers on installation, operation and servicing of specific units.

At least one hydraulic equipment manufacturer regularly conducts a school on hydraulic maintenance. This particular school offers an intensive two-weeks course in the fundamentals of hydraulics and the essentials of maintenance. It consists of both classroom and laboratory work. The school is intended primarily for your maintenance men.

Larger users sometimes prefer to organize their own school when they have a sizeable group to be trained. They can usually obtain the services of an instructor from a hydraulic equipment manufacturer for short periods of time.

Various general instruction books are also obtainable. The book "Basic Hydraulics," while intended primarily for the use of the Navy in their hydraulic training program, has information useful to maintenance men on industrial hydraulic equipment. It is available from the U. S. Government Printing Office in Washington, D. C. A more recent book "Oil Hydraulic Power and Its Industrial Applications" by Walter Ernst deals with hydraulic equipment generally, and is published by McGraw-Hill. The Ford Motor Company and General Motors Corporation each have made up their own hydraulic service manuals for use in their training schools. These manuals do not in all cases deal with current hydraulic equipment but are valuable for the fundamental information they contain. They are not offered to the public but may possibly be obtainable through the companies. Many of the oil companies publish booklets on hydraulics which contain helpful information on maintenance, particularly pertaining to hydraulic oils. Technical articles on fundamental hydraulics and good maintenance practice are appearing in a number of trade and society journals including *Machine Design, Product Engineering, Applied Hydraulics* and others. Many of these articles contain information helpful in the training of hydraulic maintenance men.

In short, ample educational material for training maintenance men in hydraulics is available. But the biggest problem in hydraulic maintenance today is a human rather than a mechanical or technical problem: it is the selection of the right man for hydraulic maintenance and the training of that man as a specialist in hydraulic maintenance. The user can make the largest contribution to his own satisfaction with hydraulic systems by recognizing his need for qualified hydraulic maintenance men and seeing to it that his men are trained.

Select good men for your hydraulic maintenance and train them as specialists.

END No. 8

Set up a planned program of systematic preventive maintenance for your hydraulic equipment.

It is the policy of some users to let their hydraulic equipment operate without attention of any kind until it fails. Don't expect hydraulic equipment to operate without maintenance altogether. It is true that in theory, hydraulic equipment which is properly designed should last indefinitely under ideal operating conditions because it is self-lubricating and therefore subject to negligible wear on clean oil, and because it automatically protects itself from overload and stalls without damage. Actually the operating conditions seldom remain ideal except in the laboratory. While hydraulic equipment may reasonably be expected to require less maintenance than other methods of power transmission and control, it does require some care to provide this advantage. Nevertheless, some plants expect hydraulic equipment to operate indefinitely without preventive care of any kind, and wait for a breakdown or a failure to do maintenance work. The resulting maintenance cost is usually considerably higher than would have been required if some plan of preventive maintenance had been followed.

It is difficult to persuade many users that preventive maintenance is worthwhile, and that the carrying of spare parts or units on vital machines is economical. Many still regard maintenance only as the repair work which is necessary when a failure occurs.

How long would your automobile last if you didn't carry out the preventive maintenance recommendations of the manufacturer? How long would your car operate

satisfactorily without a breakdown if you never checked the oil level, never changed oil, never lubricated it, never replaced the oil filter, never checked the air in your tires or never checked the many other points which you now do? The satisfactory operation and long life of our automobiles today results partly from the fact that most of us do give them preventive maintenance. We seem to find that the cost of the preventive maintenance is less than the cost of breakdowns which would result without it. And we also probably find that it is more convenient to have the maintenance work done when we want to rather than when we have to. Preventive maintenance is the nearest guarantee to uninterrupted use of an automobile, or to uninterrupted production of a machine tool.

Preventive maintenance will not eliminate breakdowns—it will only minimize them. It may require more men than you are now using, or it may keep maintenance men busy who now stand around waiting for jobs. Its purpose should be to save on lost production costs rather than to save costs in the maintenance department.

In the fields that are most conscious of maintenance costs the best results have been obtained by using highly trained specialists as maintenance men on a planned program of preventive maintenance. A notable example is the transit bus field where the cost of actual maintenance over the eight to ten year life of a vehicle may average as much as three times the initial cost. In this field preventive maintenance is acknowledged to be economical by almost all operating companies.

Preventive hydraulic maintenance is being used successfully by a number of industrial companies, but it has been developed to a very high degree by the commercial airlines. Almost all commercial aircraft flying today incorporate complete hydraulic systems subject to most of the things which can happen to hydraulic equipment on industrial machinery, plus a few more which are peculiar to airborne equipment. Airlines cannot afford breakdowns for reasons of safety, and do not want their equipment out of service unexpectedly for repairs because of scheduling. They therefore use a system of planned maintenance which includes checkups and periodic replacements at intervals based on experience. For example, the pumps on most airlines are visually inspected every 50 flying hours, and replaced with an overhauled unit every 1,000 flying hours (that, incidentally, is the equivalent of about 300,000 miles). The removed unit is then overhauled and held in stock as a replacement. A similar procedure is followed on other items of hydraulic equipment on the airplane. The safety record of hydraulic equipment in aircraft service indicates the success of this program. The airlines find that it is more economical than having equipment out of service unexpectedly.

Perhaps a program as definite and detailed as the airlines use is not practical for many industrial plants, but it might be applicable to others, or to particular machines which are critical to your production. It would depend on the cost of maintaining such a program versus the cost of lost production which might otherwise result.

In general, there is a great deal more service life built into hydraulic equipment than is now being obtained from it. Improved service life hinges on the ability of the user to maintain within the hydraulic system, while it is operating, those conditions which are necessary for long service life. You can make preventive maintenance do this for you.

A good preventive maintenance program on hydraulic equipment begins when you first think about a new machine. Then is when your preventive maintenance is least expensive and most effective. You can forestall many hydraulic maintenance problems by taking maintenance into account from the beginning. After you take delivery on a new machine, or for the old machines you already have, regular and frequent inspections of specified points will help prevent breakdowns. Things like leaks, the oil level and the condition of the hydraulic oil can be determined by visual inspection. The life of solenoids and bearings can be calculated with fair accuracy. Excessive pump wear is usually evidenced by gradual increase in the cycle time. Plugged suction filter can usually be spotted by sound. Oil temperature above normal always warrants investigation. In short, hydraulic equipment almost always gives warning of trouble before breakdowns actually occur. But someone must notice the symptoms and do something about them if they are to do you any good.

A preventive maintenance program which provides such inspections regularly makes it possible for you to schedule the actual maintenance work when it will not interfere with production and when it will best work into your maintenance schedule. The maintenance departments of companies using this system always have work scheduled ahead of them, instead of having some men waiting for jobs, and the plant usually benefits by a better record on down time.

Don't let faulty maintenance methods rob you of the life which is built into your hydraulic units. Hydraulic equipment operated within recommendations and on clean oil is usually capable of lasting as long as the machine tool on which it is installed. Premature failures resulting from neglect, lack of inspection, or a policy of waiting until a machine breaks down before doing any repair work, can be very costly to you both in replacement of parts and units of hydraulic equipment, and in lost production time. Premature failures can be stopped by a good program of preventive maintenance.

Set up a planned program of systematic preventive maintenance for your hydraulic equipment.

END No. 9

On actual repairs, analyze and isolate hydraulic trouble before dismantling any part of the hydraulic circuit.

The user should establish a definite procedure in hydraulic maintenance for his equipment. The approach of many maintenance men to a servicing job is to start at one end of the machine and dismantle every hydraulic unit in order. This is an illogical and expensive way to locate the trouble, and often results in there being more wrong with the machine when the procedure is finished than when it was started.

A better procedure is one of diagnosis, where the maintenance man has a hydraulic circuit diagram of the machine and is familiar with it, and where he analyzes the symptoms with respect to the circuit and attempts to isolate the cause of the trouble. Hydraulic units or piping should not be dismantled before weighing all the possibilities and determining that there is something wrong with the unit.

Actual repairs to a hydraulic system after the trouble has been located should be made only by a specialist who has been trained in the "know how" or hydraulics. It is usually a mistake to machine parts which seem to bind or stick, or to make up your own parts except in emergency. The fits, the limits, the material analysis, the heat treatment and the finish of parts are important

factors for the correct operation of hydraulic units, and these factors are usually known only to the manufacturer.

To avoid recurrence of repairs which are not normally repetitive, it pays to locate the cause of the trouble and correct it if possible. This seems obvious but frequently it is not done. Service Engineers of hydraulic equipment manufacturers are trained to diagnose hydraulic trouble before attempting repairs. They also try to remove the cause of hydraulic trouble in addition to correcting the effects. In the long run it saves time and money.

On actual repairs, analyze and isolate hydraulic trouble before dismantling any part of the hydraulic circuit.

END No. 10

Make use of the repair or service department of the manufacturer of your hydraulic equipment on any hydraulic maintenance problem you are not able to handle.

Companies whose maintenance men are not trained as specialists in hydraulic maintenance should not attempt to repair most hydraulic units, or to do actual maintenance work on a hydraulic circuit, until they have acquired the "know how" necessary for such work. Until that time you will do better to call in the service representative of your hydraulic equipment manufacturer, or to return your units to the factory when they need repairs.

Even if your maintenance men are fully trained specialists in hydraulics, there may be some service problems which they cannot correct. In such cases, calling in the service representative of the hydraulic equipment manufacturer may be your least expensive procedure.

If you return hydraulic units to the factory for repair, you can help your maintenance department by giving the hydraulic equipment manufacturer as much information as you can about the conditions under which the failure occurred, and asking for a report on the condition of the unit. Most hydraulic equipment manufacturers are happy to give you a report on request, but they are seldom able to determine the exact cause of the trouble from the unit alone without supplementary information on the circumstances. It will be worth your while to go to this extra effort because the report from the hydraulic equipment manufacturer may be helpful to your maintenance department in avoiding similar trouble in the future.

If you require the help of a serviceman from the hydraulic equipment manufacturer, be sure someone from your maintenance department is with him during the repair. The hydraulic serviceman will be glad to show your maintenance department what is wrong, and to instruct your group on the care of the hydraulic system. You should take advantage of this.

Most suppliers of hydraulic equipment try to maintain an adequate service organization for handling repairs or service calls to aid the user on hydraulic service problems which he is not able to handle.

Make use of the repair or service department of the manufacturer of your hydraulic equipment on any hydraulic maintenance problem you are not able to handle.

In summary, good hydraulic maintenance practices which will reduce lost production costs are within the reach of every user if he keeps in mind and puts into practice this plan:

1. Recognize the fact that the user of hydraulic machinery can have more control over hydraulic maintenance than either the machinery builder or the hydraulic equipment manufacturer. Use this control effectively to reduce down time.
2. Standardize on one make of hydraulic equipment for all hydraulic machines in your plant.
3. Maintain a stock of spare hydraulic units and parts.
4. Before you buy a hydraulic machine, check to make certain it will meet your production requirements *and* your maintenance requirements.
5. Use the best hydraulic oil you can obtain for your machine, keep it in good condition, and change it as often as necessary.
6. Instruct the machine operator on the functions and limitations of the hydraulic equipment on his machine.
7. Select good men for your hydraulic maintenance and train them as specialists.
8. Set up a planned program of systematic preventive maintenance for your hydraulic equipment.
9. On actual repairs, analyze and isolate hydraulic trouble before dismantling any part of the hydraulic circuit.
10. Make use of the repair or service department of the manuafcturer of your hydraulic equipment on any hydraulic maintenance problem you cannot handle.

You have probably found nothing you didn't already know in the ten points of this plan. In fact, you have likely been using some parts of this plan all along. But if you really want better results, why don't you start using *all* the points of this plan?

Discussion by W. H. Fowler

The Pure Oil Research and Development Laboratory

Mr. Hayden is to be congratulated on his very comprehensive presentation of the factors involved in good hydraulic maintenance practice. It has been pointed out that the primary goal should not be to reduce costs in the maintenance department, but to reduce breakdown costs in lost production. In this connection, it might be well to emphasize that the hydraulic lubricant plays an important role in maintaining production, for as the figures show, 70% of the service calls have been attributed to this item alone. For the most part, the causes given can be traced to either contaminants entering the system or those resulting from the inability of the lubricant to forestall oxidation and rusting. The contaminants entering the system can best be controlled by establishing systematic drain and cleaning periods as required by the specific installation. The need for a dirt tight reservoir with adequate air and oil filters has already been mentioned and is of paramount importance in maintaining the cleanliness of a hydraulic system.

It is readily apparent from the figures given that good judgment must be exercised in the selection and care of the lubricant to assure satisfactory performance of the unit. Quite often, for the sake of economy or due to the operating conditions of a particular unit, a highly refined straight mineral oil may be considered to be satisfactory. Yet in selecting such a lubricant, we may overlook some factor which can seriously affect performance. To cite an example, a case was recently encountered where the use of a straight mineral oil appeared justified. Yet in a few weeks time, 0.2% water had accumulated in the oil causing extensive rusting which in turn necessitated shutdown. No source for this contamination could be found other than condensate from the air. An ASTM rust test on the oil indicated poor performance in the presence of water, and the addition of a rust inhibitor was required to correct the trouble.

I do not wish to infer by this example that all hydraulic systems require inhibited oils. However, Mr. Hayden has stated that hydraulic machines should be operated on the best quality oil regardless of price. As a representative of an equipment manufacturer, he is in an excellent position to be familiar with the performance of the various lubricants available. Furthermore, he has listed improper oil, rust, and oxidation as three of the five reasons for service calls. This to me is a definite indication that the equipment users could benefit from the experience gained by the equipment manufacturers and lubricant suppliers as well as the J. I. C. Committee on hydraulics. By doing so, and also following the other points of Mr. Hayden's maintenance program, the goal of decreased maintenance costs and increased production may be more rapidly achieved.

NUMBER 1

MANUFACTURE OF LUBRICATING OIL

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Mr. Larson graduated from Armour Institute of Technology with a B.S. degree in mechanical engineering. Upon graduation, he became a lubrication engineer with The Texas Co. in Chicago. While in Chicago, in 1915, Mr. Larson established a night class at Armour Institute on lubrication engineering, for his fellow workers.

During World War I, he served as lubrication engineer, first in a civilian capacity, later becoming 1st Lieutenant, Aviation Section, Signal Corp, 1st Provisional Wing at Mitchell Field, Long Island. Upon discharge from the Army, Mr. Larson joined the Sinclair Refining Co., whose home offices at that time were in Chicago, as Assistant Supervising Engineer in charge of staff and lubrication engineers throughout their territories. After serving as Supervising Engineer in charge of field and technical services, fuels and lubricants, he was, in 1937, made Chief Consulting Engineer, and has served in this capacity since that time.

Mr. Larson is the inventor of the Visgage, a pocket Saybolt viscosity measuring instrument; Dilut-O-Meter for checking dilution motor oils; and other automatic viscosity indicating instruments. He is the author of numerous papers for several engineering societies.

As well as being a member and former Director of A.S.L.E., Mr. Larson is also a member of S.A.E., A.P.I., A.S.M.E., A.S.T.M., Institute of Aeronautical Sciences, Institute of Naval Engineers and Institute of Petroleum, London. He is registered as a professional engineer in New York State.
During World War II, Mr. Larson served as Expert Consultant to Secretary of War, covering fuels and lubricant problems.

Petroleum oil and its derivatives are a fascinating study. Under the pressure of our civilization new products are being developed constantly and each year the petroleum technologist explores new fields. This ever expanding horizon of petroleum activity challenges the interest of the lubrication engineer. While it is true that detailed knowledge with respect to the vast number of petroleum products and the processes whereby these myriad products are refined becomes complex, yet the fundamental principles are not complex beyond the understanding of the average individual. A basic understanding of the principles of modern refining of lubricating oils, opens a whole new vista of product data and information for the lubrication engineer.

Lubricating oils are manufactured from an unusual substance, crude petroleum. This crude oil is a natural fluid which is recovered from the ground, but only at well defined geographical locations. Before portions of crude petroleum oil can be used as lubricants, certain undesirable fractions must be removed by a process known as refining. This process includes the actual separation into desired groups with similar or compatible properties; the numerous hydrocarbons which are mixed together and form the crude oil as it is taken from the ground.

In order to get a little better understanding of the crude oil itself and why it must be processed in this manner, it would be well to point out a few fundamental facts in order to explain the chemical nature of this substance. In ancient times it was called "bitumen" and was obtained from shallow wells or outcropping. When analyzed it was found to consist of a complex mixture of hydrocarbons together with small quantities of other materials. The origin of crude, according to a prevailing theory stems from animal matter which died millions of years ago, the same way as dying vegetable matter has formed into coal.

Regardless of its complex characteristics and innumerable by-products, all crude petroleum is made up almost exclusively of just two of the elements, carbon and hydrogen. The elements, carbon and hydrogen, can combine in many ways to form thousands of different structures called hydrocarbons. These forms vary from gasses through liquids of various viscosity to quite plastic bodies like asphalt, or even solid bodies, like wax.

Crude oil then, is a mixture of many hydrocarbons in irregular proportions. Other compounds present contain sulphur, oxygen and/or nitrogen. Some are gasses, others are light fluids like gasoline, still others are fluids like a light spindle oil, and finally come heavier fluids like motor, aircraft or steam cylinder oils. Somewhere in this mixture are paraffin wax molecules which are solid when at room temperature. There are also materials like tars and asphalt, but these are usually found in very small quantities.

Now the job of refining is to separate these different hydrocarbons, or oils, so that they may be used to advantage.

Refining methods have changed through the years and most of the older, wasteful methods have now been discarded in favor of modern, economical processes by means of which reliable and very uniform lubricating oils may be produced.

Composition of Crude Oils

The various crude oils differ widely in their composition. Those crude oils produced and processed in the United States may be divided into three classifications:

(a) Paraffinic or Paraffin Base (Pennsylvania)
(b) Napthenic or Asphaltic Base (Coastal)
(c) Intermediate or Mixed Base (Mid-Continent)

The major difference between the crude oils produced in these different geographic fields is the relative proportions of three basic hydrocarbon groups which make up the crude oil. Pennsylvania crude contains a very high percentage of paraffin, and a low percentage of napthenes, and still a lesser amount of aromatics. Such high paraffinic crude oils are processed almost entirely for lubricating oils. "Coastal" or California crude oils contain a high percentage of napthenes and low percentage of paraffins and a lower amount of aromatics. These Coastal crude oils, when made into lubricating oils have a natural low flow or pour point because of the low paraffin content or freedom from wax. The Mid-Continents are intermediate in the paraffinic and napthenic proportions and also contain a low percentage of aromatics. Some of the selected Mid-Continent crudes are nearer to Pennsylvania crude in paraffinic content and are, therefore, referred to as paraffin base. In general mixed base lubricants resemble paraffinic lubricants more than they do the napthenic lubricants.

Composition of Refined Oils

The physical and chemical characteristics of the lubricant affect its behavior, and have definite relation to practical lubricating problems. All lubricating oils reflect the composition of the crude from which they are refined or the paraffinic-napthenic proportions that make up their composition. Making the best lubricants for all around service involves more than the selection of a particular type of crude. This does not imply that the selection of the crudes is not important, but modern refining processes have changed this limiting factor of crude source. Because of the wide variations in crudes, refining processes differ widely. Very seldom do any two refineries employ exactly the same sequence of processing the crude to finished lubricating oils.

Lubricating Oil Refining

Not only do the crudes vary widely in their mixtures of paraffinic and napthenic compositions, but also the lubricating oil fractions differ from each other in boiling points, gravity, and viscosity.[1] For example, in a given series, the component composed of the smallest number of carbon and hydrogen atoms has the lowest boiling point, specific gravity and viscosity. As the molecule complexity increases, the boiling point, specific gravity and viscosity also increase.

The refining of lubricating oils from crude petroleum consists essentially of separating the desirable constituents from undesirable ones by processes of distillation or fractionation, dewaxing, chemical refining and filtration.

[1] See Physical Properties of Lubricants, published by the American Society of Lubrication Engineers.

Distillation of Crude Oils

Petroleum crude oils are complex mixtures of many hydrocarbons varying from low molecular weights and simple chemical structures on up to very high molecular weight fractions which are complex structures. The first step in the refining of a particular crude oil consists of separating the various hydrocarbons into fractions of similar molecular weights. Since the boiling points of petroleum hydrocarbons are approximately proportionate to their molecular weights, temperature distillation separates the crude oil into components whose molecular weights and sizes are similar. The lower boiling point liquid fractions from crude petroleum include gasoline, naphtha, kerosene and gas oil or Diesel fuel oil. The higher boiling fractions consist of light and medium lubricating oil distillates and waxes. Heavy residual products including cylinder oils, high melting point waxes, resins and asphalt are end products. Distillation does not separate hydrocarbon-molecules of similar types so that the proportion of paraffinic, napthenic and aromatic constituents are as in the original crude being run thru the still. Raw lubricating oil fractions require additional refining treatment in order to remove the waxes and the undesirable unstable fractions, resins, tars or asphalt and other unwanted matter. This segregates the more desirable components into lubricating oils.

A study of the flow diagrams, Figures 1 and 2, show the several refinery steps involved in the manufacture of modern lubricating oils.

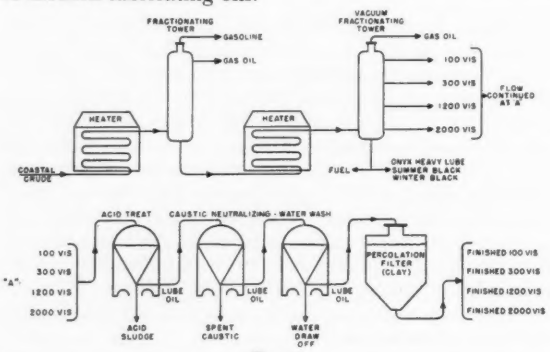

Fig. 1
Typical flow chart—coastal crude.

Dewaxing

The lubricating oil fractions obtained from paraffin and mixed or intermediate base crudes contain appreciable quantities of paraffin wax. The majority of this wax must be removed in order to prevent its congealing in oil lines, screens and filters of equipment being lubricated at temperatures below its freezing point. This dewaxing lowers the pour point of the lubricating oil.

Dewaxing consists essentially in chilling the lubricating wax distillate and allowing the wax to crystalize. The solidified wax can be readily separated by filtration thru a filter press. In the case of solvent dewaxing, the selective solvent when mixed with the lubricating fractions and chilled to temperatures below zero remove two types of wax from the oil, namely crystalline and

micro-crystalline. The former are removed from the neutrals (low viscosity) and the latter from bright stocks. The solvent extraction methods are considered superior to the older plate and frame filter press and centrifuge dewaxing processes in that dewaxing is accomplished much more efficiently and thoroughly. Removal of the wax in this manner improves the pour and low temperature characteristics of the finished oil.

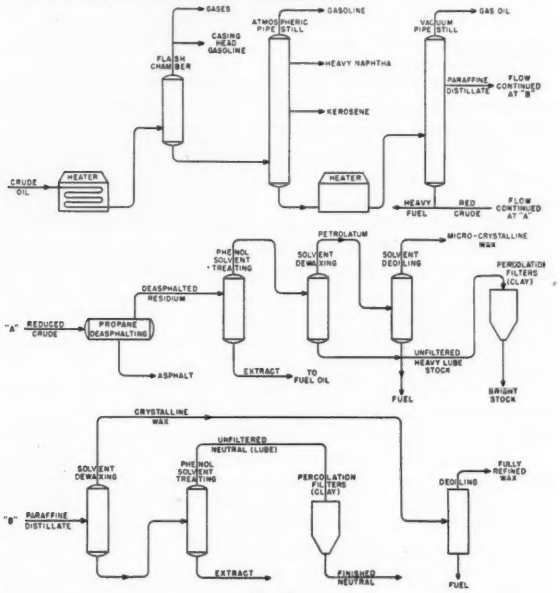

Fig. 2
Typical flow chart—mid-continent crude for lube oil manufacture.

Chemical Refining

Either before or after the removal of the wax, lubricating oil components or fractions contain varying amounts of undesirable hydrocarbons, including resinous and asphaltic materials. These undesirables must be removed by chemical or solvent refining in order to give the finished lubricating oils the desired stability or resistance to oxidation, sludging and carbon formation, proper viscosity temperature relation (Viscosity Index), for low rate of change in viscosity with change in temperature and also separation from water when used in circulating systems such as turbines.

One of the earliest refining methods of the raw lubricating oil fractions consisted of treatment with sulphuric acid followed by caustic neutralization. This method is referred to as conventional refining. Most of the impurities and some of the desirable hydrocarbons are removed by this drastic method. The sulphuric acid treatment improves the stability and reduces the sludge and varnish forming tendencies of the finished lubricating oil. In the case of heavy lube distillates or residual oil stocks from crudes of high asphalt content, acid treatment improves the color and carbon residue of the finished lubricant or cylinder stock.

Coastal lubricating oils are almost always subject to acid treatment, including the alternate action of sulphuric acid, caustic soda and washing with water in that order. The oils are subsequently filtered to obtain desired color and to remove any deleterious matter that may have found its way into the oil in the refining procedure.

In recent years important advances have been made in the field of lubricating oil manufacture. The improvements apply not only to the methods of fractionating crude oil and lubricating distillates, but more especially to the solvent extraction or solvent treating processes which make lubricating oils of much higher quality than with the conventional refining methods. Thus in the case of paraffin base oil manufacture, the solvent refining process is somewhat more complicated than in the case of acid treated coastal oils.

Solvent extraction of lubricating oils with suitable selective solvents is the most practical and efficient means today for separating the more aromatic and asphaltic types of hydrocarbons from the desirable naphthenic and paraffinic type hydrocarbon constituents present in the raw lubricating oil distillate. By increasing the paraffin oil content thru solvent extraction, the finished oil is improved in viscosity index,[1] stability against oxidation, sludge and varnish forming tendencies. Solvent extraction processes depend on the type of selective solvent action of certain organic liquids used and the different nature or type of hydrocarbon in the lubricating oil distillate. Thus having little or no solubility for paraffinic hydrocarbons, and some for naphthenic hydrocarbons, and more for the aromatic type, the paraffinic ratio most desired by the refiner can be controlled by the solubility of the selective solvent used. There are several variations in the solvent extraction process as used by different refiners. Some refiners use only one solvent in their extraction process, while others use two or three solvents. The refiner selects the type of process best fitted to the type of crude oil being refined; what lubricating oil products are to be made; what V.I. (viscosity index) of the finished oils; and what quantity of each grade. The main object of solvent treating process is to sort out of the thousands of hydrocarbon compounds those possessing desirable characteristics as lubricants and discarding the compounds which have undesirable characteristics as extracts. It performs this sorting action efficiently, uniformly and economically. There is a point of diminishing return in solvent treating, whereby if treatment is too severe the refiner may remove from the oil not only undesirable constituents, but also desirable constituents with respect to the desired qualities of the finished lubricating oil. Thus his yield is cut materially.

The solvent de-asphalting step sorts out and discards the resins, gum and asphalts which are found in the heavier raw lubricating oil fractions. The solvent extraction step sorts out with a high degree of selectivity the chemically active components which readily change chemically under service conditions to darken in color, form sludge and carbon deposits and cause increase in viscosity. Also this step sorts out the compounds in accordance to shape. This is important because the shape is directly related to viscosity index, which is an indication of the resistance to change in viscosity with changes in temperature. These are the long, thin stretchy compounds. The short, fat compounds which are of low

viscosity index are discarded. The solvent dewaxing step removes the wax from the lubricating oil fractions generally after the raw stock has passed thru the first two steps of de-asphalting of heavy stocks and solvent extraction of neutrals or light and medium lubricating oil cuts. Some of the better known solvent treating processes are:

(a) Furfurol Extraction
(b) Duo-Sol Process
(c) Propane De-Asphalting
(d) Phenol Extraction
(e) MEK Dewaxing
(f) Edeleanu Process
(g) Phetone Process

Filtration

The final refining operation consists of treatment with clay or with a Fuller's earth—a type of adsorbent, to remove the last traces of the chemical refining agents and refining residues and to improve the color and demulsibility of the finished lubricating oil. Clay filtration is an indispensable operation in the finishing up of certain lubricating oils. Activated clays which are used for filtering and decolorizing purposes are made so by roasting clay at temperatures of 400 to 900 F. The method of clay filtration, the quantity of clay, the treating times and the temperatures used, vary widely depending on the charging stock, the design and the properties desired in the filtered oil. Clay adsorbents may be applied by the contact method which consists of intimately mixing the finely powdered material directly with the oil, heating the mixture to the desired temperatures and separating the spent clay by filtration through a filter press; or by percolation method which involves the passing of the oil slowly thru a deep bed of granular clay adsorbent until the composite oil possesses the desired properties. Viscous oils such as residual steam-refined stocks are customarily diluted with naphtha before filtering to reduce the viscosity or body to facilitate flow thru the bed of filter clay. The mixture is redistilled leaving the filtered cylinder or bright stock to be used or blended as required. The first oil thru the fresh clay has a very light color due to the highest contact ratio of the clay and oil. The discharged oil stream gradually darkens as the percolation of additional oil flows thru until the clay is saturated with resins and asphaltic materials as indicated by the color of the oil stream. The oil flow is then cut off.

Blending

The final stage of the preparation of the lubricant for the market is that of blending. The blending stocks called neutrals (light oils, SAE 10 and SAE 20 grades), and bright stocks (heavy oils, SAE 60 or heavier) are mixed in the right proportions to produce oils of given viscosities, or in the case of motor oils the correct SAE viscosities. It is usually during the blending process that any special chemical compounds that may be required in the finished product are mixed into the oil. The chemicals, additives or compounds are used to produce extreme pressure lubricants, heavy duty motor oils, cutting oils, compounded steam cylinder oils or marine engine oils, and many other oils for specialized uses. The nature of these additives have a great bearing on the performance of the lubricating oils. When soaps are added to the lubricating oil, greases are manufactured.

The nature, degree of refining and type of refining, the blending and the selection of the compounds or additives used to make up the various grades of lubricating oil makes each and every product different in its service performance characteristics. Samples of the various products taken at regular intervals during the refining process are tested by the control laboratory to insure consistent production and to establish the chemical and physical specifications by which the finished product is sold.

Typical examples of the lubricating oils made from different crudes and refining processes, used in blending finished mineral lubricating oils are tabulated as follows:

	COASTAL OILS		MID-CONTINENT OILS				PENNSYLVANIA OILS	
			Conventionally Refined		*Solvent Treat*			
Control Tests	200 Pale Neutral	2000 Pale Heavy Neutral	Pale Neutral	Bright Stock	200 Neutral	Bright Stock	200 Vis. 3 Color Neutral	Bright Stock
Gravity, API	21.5-23.5	20.0-23.0	26.5-27.5	23.0-25.0	29.0-31.0	26.0-28.0	29.0-30.0	24.5-26.5
Flash	Min 340	460	400	535	400	560	420	535
Fire, Min.	380	510	460	615	460	630	475	615
Vis. (SSU) @ 100 F	200-210	2000-2500	200-210	Max. 3000	190-210	Max. 2650	180-190	2365-2453
130 F	95-102	600-750	101-107	1000	100-115	850-975	95-102	870-920
210 F	42-44	95-105	45-47	150-155	45.5-47.5	150-155	44-46	145-155
Pour, Max.	—20	20	15	10	10	15	15	10-20
Color, Max.	2½	4	3	7	2½	6	3	8
Carbon Residue, Max.	.015	.39	.10	1.80	.03	.70	.035	1.50

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SUBJECT — DISPENSING EQUIPMENT
AUTHOR — ALEX P. FOX, President, Lincoln Engineering Co., St. Louis, Mo.

RE-REFINING OF USED MINERAL OILS BY TREATMENT WITH ACTIVATED CLAY AND HEAT *

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His principle activities have been in the fields of lube oil refining and technology, used oil treatment and synthetic rubber manufacture.

Mr. Ebrey has been associated with the Pennzoil Co., Mellon Institute, U. S. Rubber, Walter Kidde & Co. and now with the Phillips Chemical Co.
Mr. Ebrey is a member of A.S.L.E.

With the publication of "Re-Refining of Used Mineral Oils by Treatment with Activated Clay and Heat," the Oil Reclaiming Symposium is concluded.

The other papers, relating to the Symposium, were published in Vol. 6, No. 5 (October, 1950) issue of LUBRICATION ENGINEERING.

Introduction

The field of reclaiming involves the application of a wide variety of types of equipment whose proper field of application and principles of operation are considerably different. This paper is limited to equipment, in which used mineral oils are subjected to a purifying treatment at temperatures varying from 275 F. to 600 F., with or without steam, while being stirred and contacted with a type of adsorbent clay. This discussion is limited to used oil processing equipment which is designed and intended for use by a company or firm who process their used oil in order to make it suitable for re-use.

Equipment of this nature has been identified by several terms such as reclaimers, purifiers, and re-refiners.

In oil company refining processing of lubricating and industrial oil stocks a wide variety of processing methods are used, depending largely upon the type of crude oil used and the intended use of the finished product. Such processes as atmospheric and fractional distillation, deasphalting, deresining, acid treating, solvent extraction, solvent dewaxing, clay treatment, filtration, blending of low and high viscosity stocks and incorporation of suitable additives are used. The purpose of these processes are fairly well described by their names. The aim of these refining treatments is to produce by removal of undesirable naturally occurring components a suitable oil for ultimate use.

In all these processes where selective solvents are used, these solvents are recovered for re-use. Processing of contaminated used oils is somewhat analogous to refining in that some of these same processes are employed. In re-refining, heat is always used, if necessary or desirable, steam stripping is also employed and adsorbent clay treatment is used. The heat is usually applied in batch operation in which the fractional distillation or separation of materials on the basis of boiling points is admittedly not as efficient as that obtained in modern refining practice. Such efficient fractionation, however, is not necessary for removal of lower boiling point materials ordinarily present in used oil.

Of course, in the case of transformer and some other types of industrial oils no dilution is to be expected. The treatments which are applied in used oil processing are those refining processes which are suitable for removing the types of impurities which are present. From this viewpoint there is justification for applying the term "re-refining" to used oil processing,

During the last several years there has been renewed interest in re-refining. Some factors which have probably contributed to this are: increase in consumption of lubricating oils by large scale users, particularly in railroad diesels; improvements in re-refining equipment, re-refining activity by government agencies and increasing realization from operating experience of the economies possible from re-refining.

For obvious reasons there are four principal parties who are interested in the equipment performance results from using re-refined oil; namely, the manufacturer of the equipment in which the oil is used, the oil company, the re-refining equipment manufacturer and, above all, the user or the potential user of the products of the first three.

General Technical Principles Involved in Re-refining

It is well known that certain types of clay will, because of their large surface and pore area, adsorb or selectively remove from oil, the components which may be described as being at the extreme in dark color, high viscosity, high molecular weight and carbon and resin forming tendencies. It is generally believed that the adsorption of resinous, asphaltic, acidic materials is a physical-chemical process. The effect of clay treat-

* Paper presented at Fifth Annual Convention of A.S.L.E., Detroit, April 11, 1950.

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ment is most readily and easily observed in color improvement. Although color in itself is not important and does not relate to lubricating value, it is an indication of basic changes which are significant.

The activated clays or their equivalent are usually employed in re-refining primarily because of their high adsorbent efficiency, which is probably due to high surface area and low impurities.

The purpose of heating is twofold; it evaporates impurities of a volatile nature such as water, some acids, and other oxidation products and fuel diluents to a certain extent depending upon their boiling points and it increases the impurity adsorbing effect of the clay.

For some types of used lubricants heat should be supplemented with steam in order to obtain satisfactory fuel diluent removal. This is particularly true of used oil which is highly diluted or is to be re-refined for use in medium or high-speed diesel engines. Steam distillation of the fuel diluents from used oil employs the partial pressure principle which in effect is that with steam the material distills when the combined vapor pressure of the material and the steam equal the pressure to be overcome, which is atmospheric unless vacuum is also used. The application of this principle enables fuel diluents to be removed at a lower temperature than might otherwise be necessary or enables more diluent to be removed up to any particular temperature.

Suitable Applications for Re-refining

In general re-refining is not considered to be competitive in application with purification methods such as mechanical filters, which remove only solids and only slightly competitive with centrifuges, which remove solids and water. These types of treatment and re-refining are regarded as complementary. The use of mechanical purification equipment in conjunction with re-refining serves to reduce the amount of solids and/or water charged to the re-refining equipment and thus lessens the load on it. Wherever practical, advantage should be taken of gravity separation of water and solids before re-refining. Although most re-refining equipment will handle a reasonable amount of these materials, it is usually much more economical to separate these materials by settling and draining from the bottom of the storage tanks than it is to boil off water with electrical heat or to filter out solid sludge in the filter press.

The economic advantages of re-refining may be appropriately considered by any oil user who has a sufficient amount of used oil available at one or several central points or available to be economically transported to such points.

The most favorable conditions for re-refining by the oil user are those in which a straight mineral oil is being used with satisfactory equipment performance results. Large, low-speed, stationary diesel or gas engines are most likely to have this favorable condition for re-refining.

Another favorable combination is cases in which two general types of engines are used; one type requiring heavy duty oil for best performance and the other type of engine not requiring the heavy duty oil. For example, such cases exist on railroads where the re-refined oil can be used in switch engines.

There is a very large amount of uninhibited transformer oil in service. Many companies having this kind of oil on hand do not feel that they are justified in discarding it even though it may be in a fairly badly deteriorated condition. By re-refining this oil, it can be restored to a satisfactory condition for re-use. If desired, an oxidation inhibitor may be added to the oil after re-refining and before being placed back in transformer service.

Some users of additive oils re-refine their used oil, blend it with "as new" oil in suitable proportions and use the blend in their regular equipment with performance results which are satisfactory.

A number of large users of additive mineral oil, re-refine their used engine oils, recompound it with an additive concentrate, blend this oil with the "as new" oil and use the blend in their regular equipment. Favorable reports have been received from this type of operation.

In any consideration of re-refining the existing conditions should be carefully analyzed and studied by qualified persons including the operating personnel and by lubrication engineers and chemists, if any, so that all factors may be properly evaluated and a sound decision reached which will be beneficial to the oil user. The advice and cooperation of all four of the interested parties referred to above should be invited and expected on an impartial basis.

Re-refining Installation

Fig. 1 shows a suggested re-refining installation arrangement of storage tanks. The general purposes and advantages of this arrangement are: used oil may be mixed to obtain a more uniform charge material, water and solids may be allowed to settle and individual batches of re-refined oil may be held in intermediate storage until tested or examined.

Smaller scale operators may not wish to use as an elaborate a set-up but it has advantages for any re-refiner and is considered to be good practice.

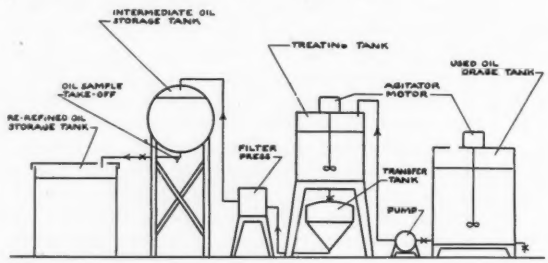

Fig. 1
Suggested re-refining installation oil storage.

Types of Re-refining Equipment

Fig. 2 is an assembly drawing of one type of re-refiner. This is shown for illustrative purposes only and in order to convey a general idea of the principles of operation of the re-refiner. Other re-refiners have such design changes as immersion heaters, vacuum on the heating tank, and a mixing tank utilizing heat exchange. Another manufacturer has a reclaimer which treats the used oil continuously with this oil passing through a bed of filter clay, then passing over an electrically heated series of concentric grooves on an incline. All well known re-refiners have thermostatic heat controls.

In the re-refiner shown in Fig. 2, the used oil is pumped to the heating tank until a float stops the pump motor at the proper operating level, a suitable weighed amount of clay is added to the oil, stirring and heating are started simultaneously and continued until a suitable processing temperature is reached. The amount of clay and the temperature can be varied to fit optimum result conditions. The degree of re-refining or even of improving the specifications of the "as new"

base oil in some respects is dependent principally upon the amount of clay used and to a minor extent upon the treating time and temperature within reasonable limits. After the treatment, the re-refined oil-clay slurry is transferred to a suitable receiving or transfer tank and passed through the filter press for removal of spent clay and other solids.

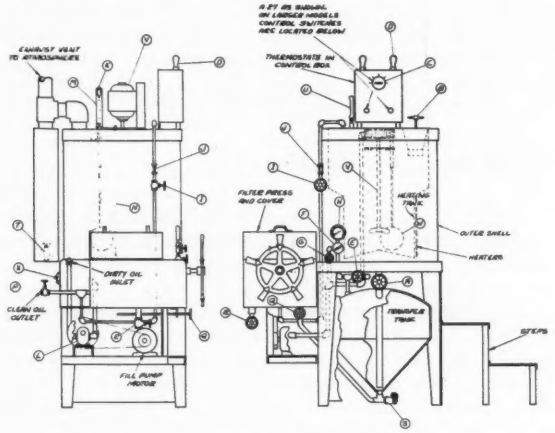

Fig. 2

** KEY **

A-Slurry Oil Transfer Valve
B-Fill Opening (for Clay)
C-Control Switch
D-Signal Lights
E-Air Release Valve
F-Air Pressure Regulator
G-Filtering Air Valve
H-Air Pressure Gauge
I-Oil By Pass Valve
J-Sight Glass
K-Float Switch (Controls Fill Pump)
L-Fill Pump
M-Oil Level Indicator
N-Measuring Rod
P-Clean Oil Shut Off Valve
Q-Filter Press Inlet Valve
R-Filter Press Pan Drain Valve
S-Transfer Tank Drain Valve
T-Condensate Drain Valve
U-Thermometer
V-Agitator Assembly and Carrier Air Fan
W-Float
X-Compressed Air Intake

Fig. 3 shows a type of steam stripping equipment for use in conjunction with a re-refiner. Steam stripping is recommended when plant steam is available and in installations requiring substantially complete removal of diesel fuel dilution. The steam stripping part of the equipment may be manually or automatically operated. Superheated steam is introduced when the oil reaches a temperature of approximately 300 F. and is continued until the desired oil-slurry treating temperature is reached.

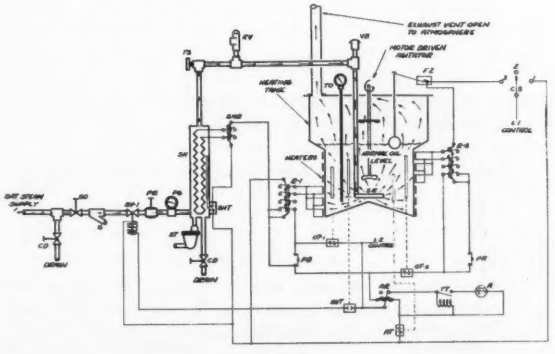

Fig. 3
(See key at top of next column)

** KEY** For Fig. 3

CS-Control Switch
R-1-Contractor Lower Heaters
R-4- " Upper "
PB-Push Button Mo. Contact
OT-1-Operat'g Thermostat, (N.C.)
OT-2-Operat'g Thermostat, (N.C.)
AT-Alarm Thermostat, (N.C.)
SVT-Solenoid Valve Thermostat, (N.O.)
A-Signal Alarm
AR-Alarm Relay
SV-1-Solenoid Valve, (N.C.)
SH-Super Heater
SHT-Super H'ter Therms't, (N.C.)
SHR-Super Heater Relay
TT-Thermal Timer (N.O.)
F2-Low Oil Float Switch (Mercury)
CD-Hand Valve Condensate Drain
SO-Hand Valve Steam Shut Off
S-Strainer
PR-Pressure Regulator
PG-Pressure Gauge
ST-Steam Trap
TS-Thermometer Steam Temp.
TO-Thermometer Oil Temp.
RV-Relief Valve
VB-Vacuum Breaker
SR-Steamer Ring

Used Oil Impurities and Their Removal

Table I lists the principal contaminants or impurities likely to be present in some of the most common types of used oil. It is estimated that on a dilution free basis approximately 95 to 99 per cent of the original mineral oil is usually essentially unchanged after use.

TABLE I

PRINCIPAL CONTAMINANTS USUALLY PRESENT IN VARIOUS TYPES OF USED OILS

Contaminant	Lube Oil	Transformer Oil	Industrial Oil
1. Water	Yes	Occasionally	Yes
2. Dilution (fuel)	Yes	No	No
3. Colloidal Carbon	Yes	Occasionally	No
4. Oil Soluble Oxidation Products:			
(a) Acids, etc.	Yes	Yes	Slight
(b) Resins	Frequently	Yes	No
5. Oil Insoluble Oxidation Products—Asphaltenes	Yes	Seldom	No
6. External Solids (dirt, metal chips, etc.)	Yes	Slight	Yes
7. Metallic Soaps (not additives)	Yes	Yes	No
8. Polymerization Products	Yes	Yes	No

This tabulation is intended to be general. It is recognized that it is not complete and that exceptions occur in individual lots of used oil. Whether or not all the impurities listed are detrimental is a debatable question on which there is no reliable information. For instance, it would probably be difficult or impossible to prove that a few percent of raw fuel dilution in a lubricating oil or a small amount of some types of oxidation products are harmful in all or perhaps any type of engines.

Table II shows the types of used oil impurities which are removed by the agents or means which are employed in re-refining.

TABLE II

USED OIL CONTAMINANTS REMOVED BY RE-REFINING

RE-REFINING AGENT		
Heat (and steam, if used)	Adsorbent Clay	Filtration
Dilution. Volatile acids, aldehydes and other oxidation products.	Dissolved sludge, less volatile acids, asphaltenes, polymerization products. Color bodies. Soap. Unexpended additives (some types).	Solids, including asphaltenes, free carbon, dirt and metal particles. Expended additives.

It will be noted that the types of materials listed in Tables I and II are practically duplicate in general nature, although the names used are slightly different. How completely these impurities are removed is an interesting point, which is discussed later in this paper.

Effects of Various Re-refining Factors

Table III shows the results of a laboratory study which was made of the separate effects of heat, steam and clay and the combined effect of each of these three factors upon the physical and chemical properties of a representative used railroad diesel oil.

TABLE III

EFFECT OF VARIOUS RE-REFINING FACTORS ON PROPERTIES OF A REPRESENTATIVE USED R.R. DIESEL OIL

TREATING CONDITIONS

	Used Oil	* Heat Only 525 F.	Steam 525 F.	0.75# Clay per Gal. No Steam. 525 F.	0.75# Clay per Gal. Steam. 525 F.
Gravity A.P.I.	24.8	24.8	24.6	25.8	25.3
Vis. SUS 100 F.	774	827	939	677	867
Vis. SUS 210 F.	68.4	70.1	74.9	64	70.1
Color ASTM	....	....	....	2½	2½
Acid No.	.014	0.06	Nil	Nil	Nil
Precipitation No.	0.03	....	....	....	....
C.C.R.* %	0.62	0.82	0.63	0.02	0.03
Vis. Index	61	61	65	59	56
% Dilution Removed	....	Nil	6.3	Nil	6.4

* Conradson Carbon Residue.

It will be seen that heating to 525 F. slightly increases the viscosity of used oil, removes some acid constituents, increases the Conradson carbon residue, but removes no significant amount of dilution. In contrast, steam stripping at the same temperature results in the collection of 6.3% of distillate. The clay treatment slightly reduces the viscosity of the used oil and produces a light colored product with a much lower carbon residue than the used oil. The combined effect of heat, steam and clay is about as expected. Unfortunately a sample of the "as new" oil was not available for comparison.

In use dilution reduces, oxidation and sludging increases the viscosity of oil. In re-refining the reverse occurs, removal of dilution increases; while clay treatment tends to reduce viscosity.

Aircraft Lube Oil Re-refining

Table IV lists a comparison of certain chemical and physical properties of used, "as new," and re-refined aircraft oil. The results show no significant differences between the chemical and physical properties of the "as new" and re-refined oil and show a good agreement between laboratory and plant run results.

Transformer Oil Re-refining

Table V lists data from three different re-refiner users of transformer oil. Treating conditions and some laboratory results generally regarded as significant measures of quality are shown.

All of these results were obtained using a re-refining treatment, in which, after the initial batch filling and heating, approximately 15% of the oil clay-slurry was withdrawn and this material was replaced at cyclic intervals after filtration of the removed slurry. Plant B used a two-pass treatment; while Plant C used a circulation system of continuous withdrawal from the used oil supply and replacement of this oil with re-refined material.

Railroad Diesel Lube Oil Re-refining

Table VI shows laboratory test results on viscosity and flash points obtained by one railroad laboratory on six lots of their used oil before and after re-refining as indicated.

TABLE IV

LABORATORY TEST RESULTS RE-REFINING USED AIRCRAFT ENGINE USED OIL

	Used Oil (1 Eng.)	Re-refined 1# Clay/gal. 470 F. Steam§	"As New"	Used Oil	Re-refined 1#/gal. 450¶	Re-refined 1#/gal. 450 F. Steam¶
Gravity A.P.I.	25.4	27.0	27.1	25.2	27.0	26.9
Vis. SUS 100 F.	....	1575	1555	....	1617	1683
Vis. SUS 210 F.	118.3	115.0	115.2	118.8	117.5	120.5
V. I.	....	97	98	....	97	97
Flash F.		540	545		540	545
Acid No.	0.25	0.03	0.03	0.25	0.03	0.03
Dil. %	1.6	....	....	1.4	....	....
C. C. R. %	....	0.6	0.6	....	0.75	0.75
Ash %	0.52	....	Nil	0.53	....	....
Iodine No.	....	15.7	16.3	....	15.4	16.6
Aniline No. C.	....	121.1	121.1	....	121.1	122.2
Color ASTM	....	6½	8	....	8	8

§ Laboratory Run ¶ Plant Runs

TABLE V

REPRESENTATIVE LABORATORY TEST RESULTS REPORTED BY THREE PLANTS RE-REFINING TRANSFORMER OIL. ROBOT SEMI-AUTOMATIC OPERATION

	Plant A		*Plant B*			*Plant C*	
	Used	Re-ref.	Used	Re-ref.[1]	Re-ref.[2]	Used	Re-ref.
Acid No.	0.28	0.08	0.30	0.10	0.09-0.05	0.75	0.04
Interfacial Tension	17.0	38	12-18	33-37	35-45	7.4	24
Color ASTM	4	2	....	....	.....	....	....

TREATING CONDITIONS

One pass 0.40 lb. clay per gallon. 300 F.

[1] 1st pass 0.85 lb. clay per gallon.

[2] 2nd pass 0.28 lb. clay per gallon.

Maximum temperature 315 F.

By-pass operation. 0.75 lb. clay/gal. initial and 0.25 lb./gal. at end. Treated 5X volume of oil in system. Maximum temperature 275 F.

TABLE VI

REPRESENTATIVE R.R. DIESEL LUBE OIL BEFORE AND AFTER RE-REFINING. STEAM STRIPPING

Lot No.	SUS Viscosity at 100 F. Before	After	Flash F Before	After
1	966	1041	410	450
2	959	1110	425	450
3	959	1068	410	445
4	720	1090	350	445
5	995	1043	440	435
6	...	1002	...	440
Average		1059		
Specification		1050 min.		440 min.

Treatment 0.66 lbs. clay/gal. 510 F.

Although the average re-refined oil viscosity is only slightly higher than minimum specification, this is not surprising in view of the fact that the "as new" oil averages approximately 1080 viscosity.

Results obtained by another railroad on several plant runs of their used oil are shown below:

Run No.	1		2		3		4		
Lbs. Clay/Gal.	0.65		0.65		0.87		0.65		
Temperature F.	515		515		515		515		
	U	R	U	R	U	R	U£	R	"As New"
Vis. 210 F.	75.3	75.1	75.8	75.6	75.1	75.3	66.7	71.8	74.0
Acid No.	1.06	0.14	1.01	0.14	0.78	0.14	0.71	0.14	0.14
C.C.R. %	1.00	0.59	...	0.67	...	0.51	...	0.59	0.35

£ Estimated to have equivalent to 8% dilution. All the above runs used steam stripping.

General Considerations

The general goal in re-refining is to produce an oil with as good as or better physical characteristics than the "as new" oil; although no direct comparison can be made of the ash and acid number results, since they are influenced by additive content, which in turn is affected by usage and refining. Since it is a generally recognized principle that oils having the same physical and chemical properties can be expected to perform in the same way under similar conditions of use, it is believed that re-refined oil which is substantially identical to the "as new" straight mineral oil will perform in service as well as the "as new" oil in lubricating, that is, in reducing friction by providing a fluid film between metal surfaces, by cooling, sealing and flushing. If there are significant differences in physical and chemical properties of re-refined and "as new" oils, then the meaning of these differences needs to be interpreted.

When heavy duty types of lubricants or industrial oils containing additives are used, it is assumed that there is good reason for the use of these types of oils in superior performance results over non-additive oils. It is generally expected that most additives of the detergent, anti-oxidant and anti-corrosion types are expended in service and removed by clay treatment in re-refining. Therefore, it is assumed that re-refined oils of this type must be substantially like the original mineral oil in properties and must have the original additive content restored in order to give performance equal to the "as new" oil. As a means of handling this situation with the practice of re-refining there are three suggestions; namely:

1. Less extended service of the oil in miles or time than would normally be practiced.
2. Blending the re-refined oil with an "as new" oil containing the proper amount of additives so that the blend has the desired additive concentration.
3. Recompounding of the re-refined oil with an additive concentrate.

In many well established mineral oil usages in plants there would be a fairly constant ratio of the volume of used oil and of "as new" oil so that it would be possible to use suggestion No. 2.

Cost of Re-refining

Table VII shows some estimated costs of re-refining 75 gallon lots of three different types of used oil. Since it is recognized that there may be fairly wide variations between cost items in different plants and in the amount of clay required for satisfactory treatment, low and high estimates are listed for each general type of oil.

TABLE VII

ESTIMATED COST OF RE-REFINING 75 GALLON LOTS

Type of Oil		Gasoline Motor		Diesel Lube		Transformer	
Max. Treating Temp. F.		450		525		325	
Treating Time Hrs.		1¼		1¾		1	
	Range	Low	High	Low	High	Low	High
Clay at 4.5¢/Lb.	0.5 to 1.0#/gal.	1.67	3.34	1.67	3.34	1.67	3.34
Electricity 35 Kw.	0.75 to 4.5¢/Kw.H.	0.33	1.98	0.46	2.75	0.26	1.56
Labor at $1.60/Hr.	¼ to full time	0.50	2.00	0.70	2.80	0.40	1.60
Filter Paper (use 5 times)		0.10	0.10	0.10	0.10	0.10	0.10
Supervision and Testing	1 to 2 cents per gal.	0.75	1.50	0.75	1.50	0.75	1.50
Misc. (depreciation, interest, auxiliary tanks, etc.)	1 to 2 cents per gal.	0.37	0.75	0.37	0.75	0.37	0.75
TOTAL		3.72	9.67	4.05	11.24	3.55	8.85
Assume 10% oil loss or 67.5 gal. recovery							
Cost/Gallon		0.055	0.146	0.060	0.167	0.053	0.13

(All above low and high cost figures in dollars)

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ASLE Technical Committees

A New Service Organization Within the Society

In keeping with the basic ASLE policy of continuing to match the growth of the Society with a corresponding expansion of its services, a new system of Technical Committees is now being organized within the Society. The structure of this new system of committees is shown in the accompanying organization chart.

The fundamental purpose of this Technical Committee organization is *to be of direct service to industry.* The committee structure has therefore been developed with this essential purpose in mind. As may be seen from the chart, the basic structure consists of two parts—a general liaison and coordinating committee known as the General Technical Committee and the individual service committees which have direct responsibility for a very definite phase of lubrication engineering.

The specific functions of the General Technical Committee are to carry out liaison with other technical societies and to coordinate and supervise the activities of the individual Technical Committees. The membership of this committee thus consists of all ASLE liaison representatives together with the chairmen of all the individual Technical Committees. In addition, the three National Directors who act as sponsors of the overall technical committee organization are ex-officio members of this committee.

The prime functions of the individual Technical Committees are three-fold:

1. Development and sponsorship of technical and practical papers and program material on lubrication and lubrication engineering.
2. Development, for publication and dissemination by the Society, of recommended procedures and practices in the field of lubrication and lubrication engineering.
3. To act as a clearing house for lubrication problems submitted by industry.

Within the above general scope, each individual Technical Committee is free to develop and carry out the details of its own program of activities.

As for the personnel of the individual Technical Committees, chairmen have now been appointed for all except the Technical Committee on Hydraulics and Hydraulic Machinery. (It is expected that this vacancy will be filled in the very near future). These chairmen are now in the process of lining up personnel to serve with them on these committees. In choosing this membership, each chairman has been asked by the Board of Directors to see that as much opportunity as possible be given to younger and/or less experienced men to hold membership and participate actively in the committee work. It is the intention that these committees be staffed with interested and willing workers.

In keeping with this aim, a *general invitation* is hereby issued to all ASLE members who have a definite interest and desire to take an active part in the work of one of these committees to write directly to the chairman of the committee of their choice, outlining their interests and qualifications. The detailed addresses of the committee chairmen are as follows:

TECHNICAL COMMITTEE ON LUBRICATION FUNDAMENTALS
Prof. J. T. Burwell
Massachusetts Institute of Technology
Cambridge 39, Mass.

TECHNICAL COMMITTEE ON LUBRICATION EQUIPMENT
A. F. Brewer
The Texas Co.
135 E. 42nd St., New York, N. Y.

TECHNICAL COMMITTEE ON PHYSICAL PROPERTIES OF LUBRICANTS
T. G. Roehner
Socony-Vacuum Oil Co.
412 Greenpoint Ave., Brooklyn 22, N. Y.

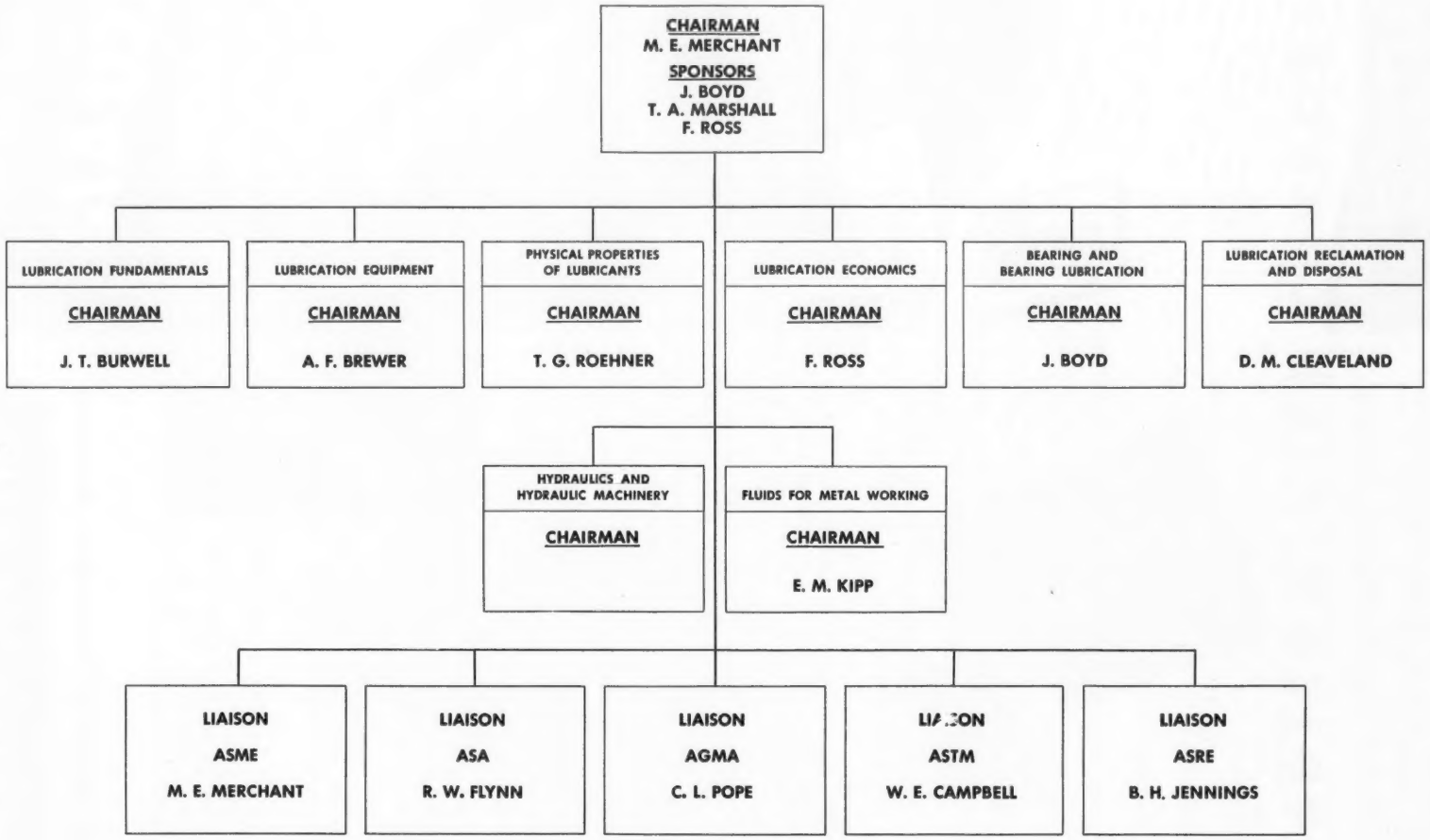
TECHNICAL COMMITTEE ON LUBRICATION ECONOMICS
F. Ross
E. F. Houghton & Co.
303 W. Lehigh Ave., Philadelphia 33, Pa.

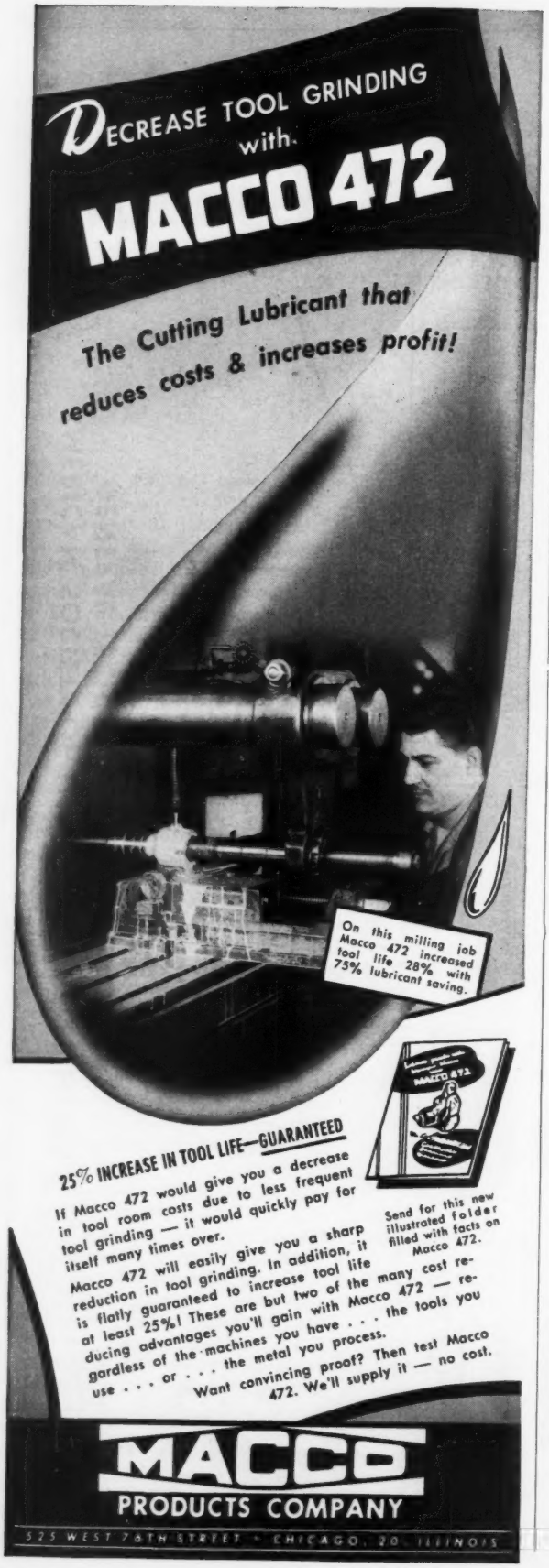
TECHNICAL COMMITTEE ON BEARINGS AND BEARING LUBRICATION
John Boyd
Westinghouse Electric Corp. Research Lab.
Ardmore Bldg., East Pittsburgh, Pa.

TECHNICAL COMMITTEE ON LUBRICANT RECLAMATION AND DISPOSAL
D. M. Cleaveland
Bendix Prod. Div.
Bendix Aviation Corp., South Bend 20, Ind.

TECHNICAL COMMITTEE ON FLUIDS FOR METAL WORKING
Dr. E. M. Kipp
Aluminum Co. of America, New Kensington, Pa.

AMERICAN SOCIETY OF LUBRICATION ENGINEERS
GENERAL TECHNICAL COMMITTEE CHART
OCTOBER 30, 1950

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MAINTENANCE SHOW

January 15-18, 1951

Cleveland Auditorium, Cleveland, Ohio,

L. C. Morrow, Consulting Editor, *Factory Management and Maintenance,* will serve as General Chairman of the conference. An 18-point program of plant maintenance techniques has been arranged. The general conferences will open with a discussion of preventive maintenance.

At this session, speakers will discuss inspection procedures and frequencies, records and reports, and training personnel for maintenance work.

The group will then divide for four sectional meetings on maintenance of electrical equipment, maintenance of power plant and heating equipment, maintenance problems of the small plant, and selection and maintenance of lighting equipment.

On the second day, the general session will be devoted to organization and management for maintenance. This discussion will include maintenance costs, their control and budgeting, incentive payment of maintenance workers, and planning and scheduling maintenance operations.

Four sectional conferences will then consider specialized maintenance for chemical, paper and paper product, food processing, and metal working plants.

On the third day, The American Society of Lubrication Engineers will conduct a panel on lubrication. Mr. Charles L. Pope, Eastman Kodak Co. and Past President of A.S.L.E., will act as Chairman. Subjects to be covered and the individuals serving on the panel are:

Chemistry—D. F. Hollingsworth, E. I. Du Pont de Nemours & Co., Wilmington, Del., and President of A.S.L.E.

Automotive—Don P. Morrell, Ford Motor Co., Detroit, Mich.

General Lubrication—L. B. Sargent, Jr., Aluminum Co. of America, New Kensington, Pa.

Paper Mill—LeRoy Miller, Scott Paper Co., Chester, Pa.

Steel—William M. Schuck, Armco Steel Corp., Middletown, Ohio.

Textiles—W. T. Witt, Tennessee Eastman Corp., Kingsport, Tenn.

Also, on the third day, another general session devoted to plant housekeeping will be held.

The exposition, which will run concurrently with the conference, will cover the many phases of general maintenance as applied to various industries.

A.S.L.E. will have a booth with personnel in attendance for any information on the Society, panel discussion or lubrication problems.

Advance registration cards and hotel information may be obtained from Clapp and Poliak, Inc., 341 Madison Ave., New York 17, N. Y.

Any A.S.L.E. member desiring reservations at the Hotel Statler during the conference, please contact the National office.

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NEWS OF THE SECTIONS

NEW SECTION

SYRACUSE

Representatives of the leading industrial concerns in the city of Syracuse, N. Y., met on the night of October 16, 1950, for the purpose of organizing a local Section of the A.S.L.E.

The meeting, called to order by National Secretary W. F. Leonard, was informed as to the aims and purposes of the Society and its accomplishments to date. Ex-President Charles L. Pope and Director T. A. Marshall spoke at length regarding the benefits to be obtained by the establishment of a local Section. It was the unanimous opinion of those present to effect the new organization.

An election followed immediately. Officers listed below:

CHAIRMAN—Terence F. Dundon, Carrier Corp., Syracuse, N. Y.

SECRETARY—Russell Buyea, New Process Gear Corp., Syracuse, N. Y.

TREASURER—S. B. Krutulis, Bristol Laboratories, Syracuse, N. Y.

Terence F. Dundon, the new Chairman, officiated for the balance of the meeting. Committees were also appointed for the various tasks to be accomplished.

The date and subject of the first technical session will be announced shortly.

We predict a very successful Section in Syracuse due to the intense interest shown at the original session.

YOUNGSTOWN

By M. C. Jones, Secretary

History

It was about one year ago that a small group held a meeting in a local hotel to decide whether a Section of the American Society of Lubrication Engineers should be formed in Youngstown. The courageous effort of this group resulted in the organization of this Section. Although it has not celebrated its first anniversary, it has had a membership increase of over 100%. Seven regular meetings have been held with a total attendance of 405, or an average of 58 per meeting.

It is the aim of this Section to present information concerning the development of lubricants and their application to those associated with the maintenance of industries. The Officers and Committees have been instrumental in bringing to the membership many prominent speakers.

"Due to the tremendous demand, there has been an acute shortage of pipe for pipeline installations," said J. C. Siegle, Genl. Supt. of the Tube Div. of the Youngstown Sheet & Tube Co., at the October meeting of this Section.

"A year ago, 20,531 feet of pipe was used in drilling the world's deepest well in Wyoming. It is estimated that 32,000 miles of pipe will be laid in the U. S. and Canada this year. Pipelines are rapidly replacing shipments by rail, primarily due to savings in freight cost.

"It is possible to lay two miles of 24" pipe per day. By 'grading down,' various types of crude oil can be shipped by continuous flow from producing fields to the refineries thousand of miles distant. When installing these lines, it is necessary that pipes have multiple coatings to prevent corrosion. It is estimated a pipeline properly installed will last 75 to 100 years."

Following Mr. Siegle's talk, the Shell Oil Co.'s sound film "Pipelines" was shown. The film showed details and work involved in the laying of a pipeline 985 miles long ranging from 20" to 24" in diameter. A major portion of this line was produced at the local Brier Hill Plant of the Youngstown Sheet & Tube Co. The line runs from the southeast corner of New Mexico to Wood River, Ill., and can carry 186,000 barrels every 24 hours at 750 lbs. pressure.

November Meeting:

"Not many years should elapse before gasoline from coal can be marketed competitively," predicted B. Y. McCarty, Technologist of the Tech. & Res. Div., The Texas Co.

"Several years ago, fear was expressed as to possible depletion of our crude oil resources. While this fear is no longer prevalent, research is constantly going forward at great expense to meet any eventuality. Government and refiners have for some time been able to remove oil from shale. Synthetic gasoline is being produced from coal, the coal converted to gas, the gas condensed and processed into gasoline. Both of these methods, however, present obstacles such as low yield of oil from shale and the high cost involved in the coal process.

"The petroleum industry has reached the chemical age to the point where oil is a carrier of chemicals. Many types of additives must be compounded with oil to meet the demands of modern industrial machinery and automotive requirements."

Dec. 14, 1950:

"Centralized Lubrication Systems" —L. W. Deutsch, Sales Mgr., Trabon Engineering Corp., Cleveland, Ohio.

Jan. 18, 1951:

"Bosses Night." Also, first anniversary of this Section. "What Lubrication Means to Management"—C. L. Pope, Chief Lubrication Engr., Eastman Kodak Co., Rochester, N. Y., and past President of A.S.L.E.

FORT WAYNE

By Dean V. Wills, Secretary

P. W. Uhl, Chemical Process Engr. of General Motors Diesel Engine Div. presented his views on the various types of wastes encountered in industry. His talk covered methods of preventing waste, methods of disposal, methods of reclamation, and descriptive information on processes causing dangerous wastes along with possible hazards.

During the discussion following the talk, Mr. Uhl offered suggestions to many specific problems that were brought up by members of the audience.

J. W. Hopkinson, Chairman of the National Membership Committee and President of the Penn-Petroleum Corp., Detroit, Mich., was a guest. He commented on how the application of the points of Mr. Uhl's paper could be used to demonstrate to the community what A.S.L.E. is doing.

LOS ANGELES

By F. H. Ott, Secretary

September: A tour of the Magnaflux Corp. plant, 1566 E. Slauson, Los Angeles, Cal. Magnaflux representatives participating were: L. J. Oye, West Coast Mgr., Robert Strother, Asst. Mgr., and Stanton Olson, Walter Henkes and Richard Turner, Field Engrs.

To better understand the principles of non-destructive testing, each of the four Magnaflux procedures was considered separately, particular emphasis being placed on its application to problems or parts associated with some phase of lubrication. Techniques of application—both wet and dry methods—were demonstrated. The inspection medium in the wet method is a paste of finely divided magnetic particles in light oil. In the dry method, a powder of ferro-magnetic particles is used.

In application, the flux (powder or liquid) is applied upon establishing the proper magnetic field. Faults or structural variations interrupt the field, thereby crowding some of the flux outside the surface, thus forming a definite indication of the exact location, extent and shape of the discontinuity.

A special adaptation of this testing procedure is referred to as Magnaglo, where indications with Magnaflux cannot be clearly lighted or viewed because the surface is obscured in some manner. In the Magnaglo procedure, the paste used is highly fluorescent under "black light."

Another process known as Zyglo was demonstrated, involving the application of a highly fluorescent liquid penetrant to the part. The examination of the surface is then made under "black light" (the invisible near-ultraviolet light in the range between 3,200 and 4,00 Angstrom Units in wave length).

The ultrasonic testing instrument known as Sonizon, measures accurately the thickness of any material which will reflect sound waves up to four inches thick.

At the conclusion of the meeting, a general discussion (over coffee and doughnuts) provided additional opportunities for clarification of specific points and questions.

This meeting was very successful, since demonstration played the major role.

October: Panel discussion—"Lubrication and Production." Frank Baeyerty, Supervisor of Industrial Sales Training for the General Petroleum Corp. acted as moderator and had as his panel the following:

J. W. Frier, Lubrication Engr., Kaiser Steel Co.

M. G. Angelo, Dept. Mgr., Process Control, Lockheed Aircraft Co.

M. R. Blurton, Sales Mgr., Alemite Co.

G. E. Jepson, Filtration Engr., Bowser Sales Co.

The purpose of the panel session was to show the advantages and value in proper methods of storing, handling and applying lubricants in industrial plants.

1. *Storage.* Advantages of one central storage room vs. several scattered points of inventory were discussed. The necessity of storing stock in the open in some instances was noted.

2. *Transfer.* Much of the value of the manufacturer's efforts to supply a quality product is lost by poor means of transferring the lubricant from the container to the point of use. The merits of closed systems, transfer pumps, application from the original container as against the use of separate storage facilities was approached from the viewpoint of the user and the equipment manufacturer.

3. *Product Application.* The method of applying the lubricant to the machine is determined when the machine is designed and frequently cannot be changed without great expense once the equipment is installed. A plea was made for the universities to give more attention to the matter of lubrication in design engineering.

4. *Lubrication Schedules.* Charts and index, properly handled, are effective means of scheduling lubrication. Oilers should be routed in a specific manner to avoid missing points and to gain greater efficiency. Close supervision is required because of frequent changes in personnel.

5. *Personnel.* In spite of all efforts, management generally has not been sold on the necessity of providing the proper type of man for the job of "oiling." All agreed that a substantial saving in lubrication could be made if this job and its personnel could be upgraded. It was pointed out that our Society had this task as one of its chief functions.

At the close of the formal discussion, questions from the floor concluded the meeting.

MILWAUKEE

September: "Grinding of Metals." Engineers from machine tool—grinding wheel—filter and oil industries—were on hand to answer questions on grinding of ferrous and non-ferrous metals.

October: "The Hot and Cold Working of Aluminum" by H. D. Bitner, Technical Service Mgr., Reynolds Aluminum Co. This talk covered all phases of working this important metal.

CHICAGO

By L. B. Burt, Vice Chairman

Abstract — "Hydraulic Oils, Their Use and Service," by R. F. McKibben, National Cash Register Co., Dayton, Ohio.

A program of periodic inspection of hydraulic fluids instigated in 1943 has proven to provide satisfactory operation of equipment.

The program consists of inspecting all hydraulic oil systems in the plant, at different periods, depending on the case history of the machine.

Examination of the oil includes determination of viscosity, neutralization value, and appearance. Change of the fluid is recommended in case of 10% variation in viscosity, a neutralization value exceeding 0.25, or the carrying of dirt or water in the oil.

The actual sampling and change of oil is carried out by the machine repair department, while the analysis and interpretations is done by the laboratories.

SCHEDULE FOR THE SEASON
Meetings held at Builders Club
228 N. La Salle St., Chicago, Ill.

Sponsored cocktails—6:30 P.M.
Dinner $3.00—Reservations—7:00 P.M.

Nov. 16, 1950: "The Reclaiming of Cutting Oils, Lubricating Oils and Solvents"—D. M. Cleaveland, Lubrication Engineer, Bendix Products Div., Bendix Aviation Corp., South Bend, Ind.

Jan. 18, 1951: Ladies' Night—"Land of the Pilgrim's Pride"—Norman R. Hallock, Lecturer, Traveler and Photographer.

Feb. 15, 1951: "Lubrication and Management"—J. W. Hopkinson, President, Penn-Petroleum Corp., Detroit, Mich.

Mar. 15, 1951: "Multi-Functional Lubricants"—E. M. Kipp, Chief Lubricants Div., Aluminum Res. Lab., Aluminum Co. of America, New Kensington, Pa.

Apr. 19, 1951: "Stump the Experts." Moderator—J. E. Rosnell, Technical Res. Div., The Texas Co., Chicago, Ill.

May 17, 1951: "Lubrication and Maintenance of Anti-Friction Bearings"—E. J. Higgins, C. E., Master Lubricants Co., Philadelphia, Pa.

June 22, 1951: Golf. Chairman and place later.

KINGSPORT

The fall season of this fairly recently organized Section was opened in September with "The Fundamentals of Lubrication" by T. R. Witt, Maintenance Engr. of Koda and Teca Div., Tennessee Eastman Corp.

E. L. Forbes, member of the Ex-

ecutive Committee of this Section, informs us of the possibility of the organization of a Kingsport Council of Engineering Societies. The Council would consist of representatives of the various engineering units. Its functions would be to render assistance to the various affiliated groups having any problems which might arise. It was felt that the formation of such a Council would be a tremendous stride forward in that it would combine the knowledge of the many engineering professions.

PITTSBURGH

The October meeting was entitled "Bosses Night." Speaker: D. F. Hollingsworth, E. I. Du Pont de Nemours & Co., Inc. and President of A.S.L.E.

(Editor's Note: Report of Mr. Hollingsworth's talk was received too late to include in the current issue. The February number will carry his comments.)

BUFFALO

D. F. Hollingworth presided at the September meeting. His subject covered the Functions of the Lubrication Engineer in Industry. He cited numerous instances of savings directly attributable to the studies made by lubrication engineers in the various plants. His audience felt it was the type of discussion very important to management as well as boosting the collective ego of the people in attendance.

October: "Hydraulic Fluids, Simplified" by C. R. Schmitt, Lubrication Mgr., Central Div., E. F. Houghton & Co. Mr. Schmitt is one of the outstanding authorities on hydraulic fluids and presents his subject in a practical manner, thus aiding in the clarification of the many problems relative to this subject.

November: "Some Aspects of Lubrication Greases" by L. W. Sproule, Technical & Res. Dept., Imperial Oil Co., Ltd., Sarnia, Ont., Canada.

December 13, 1950: A Symposium on Lubrication. The names of the "experts" to conduct this meeting have not been received.

BALTIMORE

By A. E. Cichelli, Chairman
Program and Meetings

September: "Lubrication and Servicing of Automatic Transmissions" —P. F. Chappell, American Oil Co.

The author discussed various types of automatic transmissions now in use and illustrated with slides the differences among them. Each type of automatic transmission has its advantages and disadvantages. Some are air-cooled; others are water-cooled. Some are a combination of torque converters with gearing and others are fluid couplings with gearing and automatic gear shift.

After showing the audience cross sections of the types now available, the importance of the proper kind of oil was brought out.

Specifications have been set up by the automotive manufacturers. The ATF rating applies to high VI oils with low pour point, high oxidation stability, and so forth that are used in water-cooled torque converters. SAE 10 oil is used in the air-cooled types.

October: "Design and Lubrication of Piston Rings"—Lee Doty, Koppers Co., Inc. The speaker discoursed on matters of ring design, ring material, and application. The lubrication problems involved, according to the author, can best be illustrated by calculating the oil film thickness remaining on each cylinder of a 6-cylinder passenger car using one quart of oil every 500 miles.

It was determined that each time a piston goes down on the intake stroke, a film thickness of .00000037 in. was left to lubricate the walls—assuming all the oil consumed passed between the rings and the cylinder wall.

PROGRAM FOR THE SEASON
Samuel Ready Auditorium
Sears Community House
North Ave. & Harford Rd.
Baltimore, Md.
8:00 P.M.

Sept. 21, 1950: "Lubrication and Servicing of Automatic Transmissions" — P. F. Chappell, Mgr. of the Technical Div., American Oil Co., Baltimore, Md.

Oct. 26, 1950: "Design and Lubrication of Piston Rings"—Lee Doty, Mgr. of Fleet Sales, Koppers Co., Inc., Baltimore, Md.

Nov. 30, 1950: "Bearing Metals—Their Properties and Uses"—H. L. Smith, Executive Technical Engr., Federated Metals Div., American Smelting & Ref. Co., Pittsburgh, Pa.

Jan. 26, 1951: "Synthetic Lubricants"—W. H. Millett, The Linde Air Products Co., Tonawanda, N. Y.

Feb. 23, 1951: "The Design, Application and Maintenance of Tapered Roller Bearings"—S. M. Weckstein, C. E., Industrial Div., The Timken Roller Bearing Co., Canton, Ohio.

Mar. 22, 1951: "Recent Studies on High Speed Friction"—W. M. Morsell & H. G. Clarke, Members of the Staff of the Franklin Institute.

Apr. 26, 1951: "Lubrication of Pumps and Compressors"—C. T. Chapman, Mgr., Ingersoll-Rand Co., Philadelphia, Pa.

May, 1951: Annual Business Meeting and Banquet. To be announced later.

NEW YORK

The subject of "Multi-Purpose Greases—A New Horizon for the Lubrication Engineer" held the center of attention at the October meeting. G. H. Link, Staff Engineer of the Shell Oil Company of New York, presented for the consideration of his audience, his views on the consolidation of the characteristics of various greases with industrial requirements, thereby cutting down the number of different greases employed in a given plant.

Mr. Link described in detail the properties of different greases and illustrated with a series of well chosen slides their uses. He cited the progress made in grease manufacturing and pointed to the recent development of mixtures of inorganic materials and lubricating oils, either synthetic or petroleum in place of mixtures of a soap base and mineral oils.

In reviewing the subject he has found that all variables can be included under three general headings. (1) Mechanical Stability, (2) Heat Resistance, (3) Water Resistance. Step by step the research chemist has been able to develop combinations from new materials such as barium strontium and lithium soap bases in conjunction with 12 hydroxy-stearates.

These new greases combine satisfactory mechanical stability with improved heat and water resistance and represent a new conception of multi-purpose use of grease. Mr. Link defined Multi-Purpose greases as a "combination in a single product of the more desirable characteristics normally found in each of several products."

CINCINNATI

By W. D. Whalen, Chairman
Section News Committee

October: "Lubrication in the Steel Mill"—C. E. Pritchard, Chief Lubrication Engr., Republic Steel Corp., and past President of ASLE.

The speaker stressed the importance of a thorough lubrication study and control system in a modern steel mill by pointing out that from $1,000,000 to $1,500,000 is spent annually for lubrication. Some of the special anti-friction bearings in a modern high-speed rolling mill cost upwards of $7500.

The increasing use of automatic lubricating units was forcefully brought to attention; some of these units lubricate over 300 bearings from a central point.

Mr. Pritchard emphasized the lubrication engineer's responsibility for the selection of the proper type of bearing and bearing material for a given application as well as the

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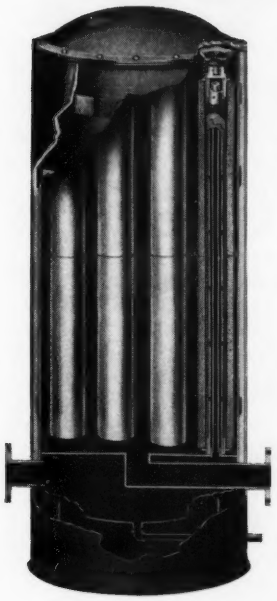

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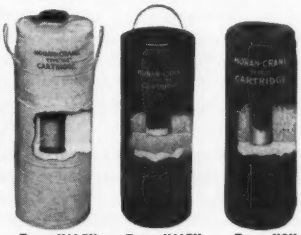

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Honan-Crane Type "MF" Cartridge

"MF" Cartridge is a perforated metal basket lined with a woven cotton sock material and uniformly packed with Palconia (specially selected cellulose fiber filtering medium). Complete removal of solids such as abrasives, scale and other foreign matter.

Honan-Crane Type "S" Cartridge

Type "S" Cartridge contains 4½ pounds of Palconia tightly packed in a specially woven cotton sock material. Performance of the cartridge is comparable to the "MF" cartridge in removal of abrasives, scale and other foreign solids.

Write for descriptive bulletins covering Honan-Crane Oil Purification Equipment for Diesel Lube and Fuel Oils, Turbine Oils, Cutting Oils, Quench Oils, Coolants, etc. State type of purification problem.

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proper type and grade of lubricant for the bearing. He recommended, as do other authoritiatve lubrication engineers, minimum inventory from the cost and ease of application standpoint.

The speaker, in closing, stated that no system is any better than the design, planning and coordination of the operators in its application.

(*Editor's Note: See Philadelphia Section news report for further details by the same speaker.*)

November: "Timken Lubrication Practices"—O. L. Maag, Lubrication Engr., Timken Roller Bearing Co., and past President of ASLE.

Every moving part must have lubrication, including anti-friction bearings. There are many types and grades of lubricants and lubricating materials, each of which is adaptable for special purposes.

The success of a lubrication engineer, in Mr. Maag's opinion, depends to a large extent on his ability to classify and select the types and grades needed for his particular plant. This practice will reduce the number of lubricants to a minimum, resulting in savings in inventory, and lowering the possibility of mix-ups in application.

In the following anti-friction bearing applications, the Timken recommendations for the lubricant is given:

Railway car wheels—straight mineral oils, with oxidation inhibitors, in winter and summer grades. The modern trend seems to be to a light soda soap grease plus a small percent of lime soap. A No. 1 grease of 60—75 viscosity at 200 F. is preferable. The advantages and disadvantages of both oil and grease lubrication were discussed. Oil requires less starting load, which is very important in a railway application. However, there is danger of draining, and corrosion protection to the bearing is absent, when idle. Greases will not drain off and give corrosion protection when idle. However, they require a greater starting load, will not circulate and in cold weather, may channel, thus not giving complete lubrication.

Automotive wheel bearings — a soda soap grease of 75 to 100 sec. viscosity at 200 F. is preferred.

Steel mills—applications are quite varied and a complete study in themselves. Generally speaking, the black stocks are preferred, mainly because they are more water repellant.

Paper mills—circulating oil is generally used, due to the presence of heat and dust. An S.A.E. 40 oil, cooled and filtered, is in common use.

Timken plant practice on hydraulically operated machines: Oil is inspected periodically. When the oil has oxidized to a 4 to 5 color it is run through a portable Fuller's Earth Filter, which will remove the oxidation products and reduce the acidity. The oil is filtered until the color is brought back to a No. 2.

On all machine tools using a cutting oil, a temperature of 75 to 80 F. is maintained by cooling, thus resulting in increased tool life, machine accuracy, and reduction of down time.

PHILADELPHIA

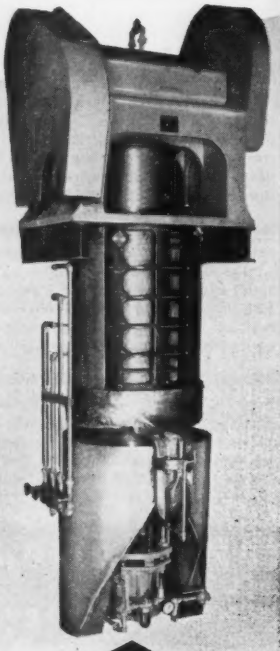
By William Eismann, Jr., Secretary

"Steel Plant Lubrication"—C. E. Pritchard, Chief Lubrication Engr., Republic Steel Corp., and Past President of ASLE.

The subject was covered in a very interesting manner at a recent meeting of this section.

The break-down consisted of 5 major points. Lubrication used in:

Norgren units help put *Continuous* in Jackson & Church *Continuous* pulp presses



An air-controlled FLOATING CONE beneath a vertical screw-type press spindle automatically maintains a pre-selected constant counter pressure against the force of the pulp feed, *regardless of the rate of feed.*

J & C selected the Relieving Type Norgren Pressure Regulator to give automatic and continuous control over the performance of their "Zenith" pulp press. Customers report no servicing required even after years of 24-hour service—much of it 7 days a week.

The Norgren Lubro-Control Unit also filters the air and provides automatic oil-fog lubrication of cylinder. Replaces inefficient, manual lubrication . . . prevents scored cylinders and damaged packings.

Get all details, Norgren Blueprint No. 104

Write C. A. Norgren Co., 234 Santa Fe Drive, Denver 9, Colo.

Norgren

Filters, Regulators, Lubricators, Valves, Hose Assemblies.

1—Steel producing
2—Steel finishing
3—Auxiliary equipment
4—Storage, handling and reclamation facilities
5—Application procedures.

Considerable interest was evinced in the slides illustrating lubrication repair stations which are employed throughout the plants. These stations, together with the trained personnel, have provided the means of satisfactory service operation of the many lubricating devices used in a steel plant. Prior to the installation of these stations, in cases of breakdown, the fault was found not in the lubrication device employed, but in the lack of trained personnel. It was found that once a definite program had been established, involving the proper training plus the provision of proper tools, the result was maximum efficiency of the equipment involved.

CLEVELAND

By W. H. Bruns, Secretary

October: "Stump the Experts."

Panel:

Ward Holland, Republic Steel Corp.
C. A. Bierlein, Cleveland Diesel Div., General Motors Corp.
E. Crankshaw, Cleveland Graphite Bronze Co.
L. T. Unks, Sun Oil Co.
F. J. Sargent, Allied Oil Co.

Judges:

B. L. Le Roy, Republic Steel Corp.
G. Johnson, The Texas Co.
R. Slaymaker, Case Institute of Technology.

This type of program is always interesting; the questions and answers providing information as well as general discussion.

November: "Filtering and Centrifuging of Lubricating Oil"—K. D. Reed, De Laval Separator Co.

Mr. Reed's talk was supplemented with working models and slides. Following the talk, an interesting discussion was held on the various filtering systems.

COVER STORY

Youngstown is known as "America's steeliest steel city." It probably produces more tons of steel per capita or per square mile of area than any other major steel area. Pittsburgh and Chicago districts produce more steel, but they are much larger geographically and have larger populations.

Within 15 miles of Youngstown's Central square, steel plants produce over 10,000,000 tons of steel yearly or over 10% of the nation's steel. Virtually all the working force in the Youngstown territory is composed of people who work in the steel mills, steel fabricating plants or on the railroads or trucklines which handle the raw materials or finished steel in and out of the steel plants.

Major steel companies in the vicinity: Youngstown Sheet & Tube Co., Republic Steel Corp., Carnegie-Illinois Steel Corp., Sharon Steel Corp., and Copperweld Steel Co.

The Youngstown Section of A.S.L.E., by virtue of its location, promises to become one of the outstanding groups in the Society.

NEW DEADLINE DATE FOR SECTION REPORTS

5th of month preceding publication month

1951
CONVENTION HI-LITES

PRACTICAL PAPERS will be featured at the 1951 A.S.L.E. National Meeting. Factual information will be presented on:

- ✓ RUST PREVENTION
- ✓ GRINDING FLUIDS
- ✓ INTERNAL COMBUSTION ENGINES
- ✓ DRAWING COMPOUNDS
- ✓ SOLUBLE OILS
- ✓ WIRE ROPE LUBRICATION
- ✓ TEXTILE MACHINERY LUBRICATION
- ✓ HOW TO MINIMIZE OIL DETERIORATION

Here Are Some "HI-LITES" of the 1951 Program!

INTERNAL COMBUSTION ENGINE PANEL—Plan to present your questions on either diesel or gasoline engine lubrication. The panel of experts will be composed of outstanding authorities in the marine, railroad, stationary and high speed diesel fields; also, in the bus and truck industry. Do not miss this opportunity to get helpful information.

IMPORTANT—To insure high priority, send your questions now to Professor W. P. Green, Illinois Institute of Technology, Chicago 16, Ill. (Unfortunately, questions cannot be answered by mail; therefore, do not send in questions unless you or your representative plan to be present at the session).

DRAWING COMPOUNDS—Two informative papers on drawing compounds: 1. Types Available, Their Properties and Uses—W. J. Wojtowicz of H. A. Montgomery, Co., Detroit, Mich. 2. Practical Application—J. T. O'Reilly of Ford Motor Co., Detroit, Mich.

If your interest is in drawing compounds, you cannot afford to miss this opportunity to hear two such specialists in the field. Bring along your questions; ample time will be provided for discussion.

TEXTILE LUBRICATION—K. M. Lowry of Deering Milliken, Greenville, S. C., is a well known textile engineer and an expert cost accountant. His paper will be based on actual surveys of textile mills and will emphasize how maintenance costs can be reduced through proper selection and application of lubricants. His presentation will be unique and many suggestions will be offered.

This paper will be followed by short discussions given by prominent authorities from textile machinery builders.

RUSTPROOFING MATERIALS—In every plant, rusting is a major problem; i.e., on your manufactured products during storage and shipment; in your production machines; or on parts between intermediate manufacturing steps. Information will be given on the types of materials available and what can be expected of each. The protection of both internal and exposed surfaces will be covered thoroughly.

Dr. W. A. Zisman and H. R. Baker, both of Naval Research Laboratory, Washington, D. C., will speak on "Theory of Rusting, Cause and Cure." This will be followed by a very practical paper on the Application of Rust Preventives by H. B. Carpenter, Esso Standard Oil Co., New York, N. Y.

Now—One grease will service all grease applications in the majority of plants

Gives ALL THESE PLANT SAVINGS:

1. **Extends TIME between greasings**—lasts longer . . . stays in bearings longer.
2. **Low-cost application**—fewer servicings and *only the one grease* to handle.
3. **Simple inventory**—Shell Alvania Grease replaces up to 20 brands formerly required.
4. **Better protection**—against heat, cold and moisture.
5. **Greater safety**—less chance of applying the wrong grease!

Gives ALL THESE LUBRICATION ADVANTAGES:

1. **Higher mechanical stability** than any conventional grease at operating temperatures.
2. **Pumpable at low temperatures**—even in unheated storage.
3. **Stable at high temperatures**—superior to the best "soda" greases.
4. **Impervious to water**—excellent resistance to washing out.
5. **Longer service life**—reduced consumption.

The "MILLION-STROKE" Industrial Grease!

A grease that will stand 100,000 punishing strokes of the ASTM Work Tester has been considered a superior lubricant.

In a deliberate attempt to break down Shell Alvania Grease, *on the same tester* the run was extended...200,000 strokes...300,000 strokes . . . 500,000 strokes! Finally, at one million strokes the test was discontinued, because this grease *would not break down*—it was still a fit lubricant both in appearance and consistency.

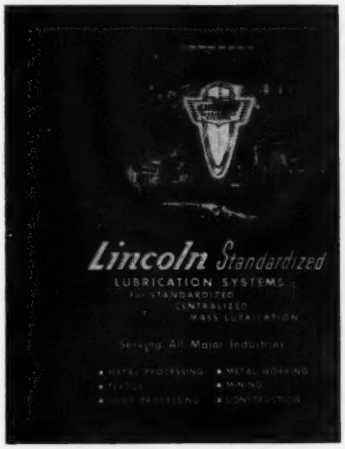
SHELL OIL COMPANY

50 West 50 Street, New York 20, N. Y. • 100 Bush Street, San Francisco 6, California

SHELL®

SHELL ALVANIA . . . The "MILLION STROKE" Grease

NEW PRODUCTS and EQUIPMENT



Lubrication Systems: Lincoln Engineering Co., 5701 Natural Bridge Ave., St. Louis 20, Mo.—A catalog "Lincoln Standardized Lubrication Systems for Standardized Centralized Mass Lubrication" is available upon request. It carries a description of typical installations in the fields of metal producing, textiles, food processing, metal working, mining and construction. The various types of systems are fully illustrated, showing automatic and semi-automatic controls.

Other items manufactured by this company are also described.

Silicone Grease: Dow Corning Corp., Midland, Mich.—A performance report is contained in a data sheet on "How to Use Dow Corning 44 Silicone Grease." It gives complete information on how to lubricate various types of bearings and suggests relubrication schedules based on laboratory testing and field experience.

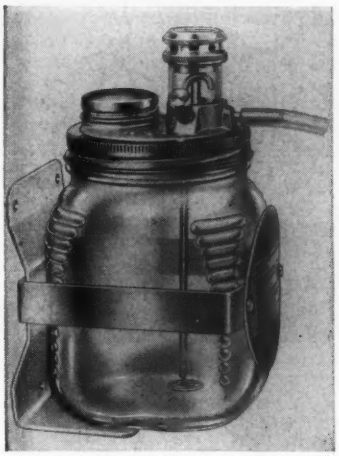
For added details, contact either this publication or the above corporation.

Hi-Temp Oils: E. F. Houghton & Co., 303 W. Lehigh Ave., Philadelphia 33, Pa. — A leaflet completely describing the testing procedure used by Houghton's research staff in setting up the following three series of Hi-Temp Oils to meet high temperature conditions up to and over 500 F., is announced. 100 series —straight mineral oils, highly refined. 200 series — semi-synthetic lubes composed of oils of varying viscosities to which have been added a synthetic organic compound. 300 series — colloidal graphite in light volatile carrying oil which is said to provide lubrication up to 1,000 F.

Heavy Duty Oils: Sun Oil Co., 1608 Walnut St., Philadelphia 3, Pa.—An illustrated booklet describing Sunvis H. D. 700 oils, of interest to production men in plants where contamination and rust are a problem and where heavy bearings are operated under heavy loads, is announced. The oils are said to keep machines clean, prevent rusting, withstand heavy bearing loads, and provide long service life with no foaming.

A description is given of the performance functions of these heavy duty oils in circulating and hydraulic systems, compressors and gear boxes.

The booklet is available free on request by writing the above company.



Top Oiler: Universal Lubricating Systems, Inc., 810 Allegheny Ave., Oakmont, Pa.—Announcement is made of two new improvements in the Universal No. 3000 Top Oiler for gasoline and gas engines. The first is a built-in air filter said to prevent road and field dust from contaminating the oil in the container. The second is an improved design of flow control eliminating the need for adjustments as the oil level falls. The use of this improved Top Oiler is said to increase engine life and reduce maintenance costs. It has no moving parts and is easily installed.

Literature available on request.

Hydraulic Fluid F-9: Monsanto Chemical Co., 1700 S. 2nd St., St. Louis 4, Mo.—Announcement is made of the availability of a bulletin on the above. This non-flammable product was developed primarily for use in industrial equipment. It is said to have an excellent combination of properties and suggested for use in such items as die casting machines, hydroelectric turbines and hydraulic presses. Physical and chemical properties and data on corrosion and stability are given in the bulletin.

"The Brooks Oil Story": Brooks Oil Co., 934 Ridge Ave., Pittsburgh 12, Pa.—The above titled publication is a description of the manufacturing techniques and production facilities of the 74-year-old grease and oil compounding firm, arranged in the form of a picture tour. It also contains information on the variety of Brooks products, planning procedure, research and development facilities, and plant equipment. Free copies are available upon writing this publication or contacting the company.

Spray Valve: The Farval Corp., 3267 E. 80th St., Cleveland 4, Ohio.—At the recent Iron & Steel Show, the new Farval spray valve was demonstrated. This new device handles either grease or oil for open gear spraying, slide surfaces or any other area where a measured amount of lubricant at regular intervals is required. The valve operates by compressed air, either as an addition to the regular Farval Dualine Lubrication System or in a complete system of spray valves served by either an automatic or a annual pumping unit.

Bulletin No. 60, describing the spray valve, is available without cost.

Lead Seal Compound: I. H. Grancell, 1601 Nadeau St., Los Angeles 1, Cal. —The above manufacturer announces the introduction of a new compound known as Lead Seal No. 960, for liquid petroleum.

It is said to provide an effective seal in all lines carrying liquid petroleum, resulting in increased efficiency in the lines, increased and uniform line pressures and greater safety.

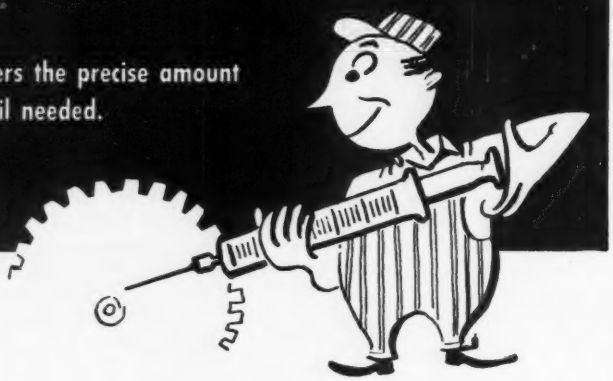
This compound, as well as their other products, is used as a joint compound in sealing, fitting, and mating of engaged threads, and can

(*Continued on page* 291)

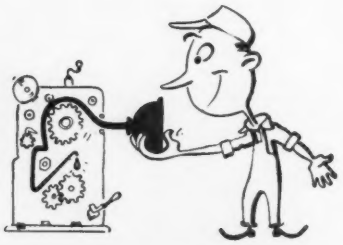
Manzel

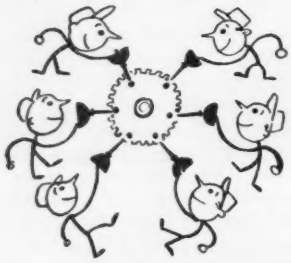
AUTOMATIC FORCE FEED LUBRICATION

Meters the precise amount of oil needed.



Reaches vital parts ordinary methods can't lubricate.





Gives each wearing point a full-time 'oiler'.

Frees manpower for more productive jobs.

Manufacturers using Manzel Lubricators report that they save their initial cost many times over in reduced labor cost, lower oil consumption, and fewer breakdowns. "Manzels" are standard equipment on many makes of engines, pumps, compressors, hydraulic presses, conveyors, and other machinery. Or...you can install them on present equipment.

Manzel representatives will gladly supply technical assistance on lubrication problems.

Manzel

Division of FRONTIER INDUSTRIES INC.

273 BABCOCK ST., BUFFALO, N. Y.

PERSONALS

F. Wesley Smith: Professional Engineer and a member of the Boston Section of A.S.L.E. announces the opening of his consulting office at 173 Hollis St., Holliston, Mass.

Mr. Smith has had 25 years' experience in supervision of engineering and sales with major oil companies and will specialize in lubricants and their applications.

H. V. Miles: Formerly Manager of Research and Development for the Honan Crane Corp., Lebanon, Ind., has affiliated with the U. S. Hoffman Machinery Corp., Syracuse, N. Y., as head of Research and Development for the Filtration Division.

Sidney G. Harris: Now associated with the Graphite & Lubricants Div., Jos. Dixon Crucible Co., Jersey City, N. J. His work will be concerned mainly with product research, development and sales engineering.

Mr. Harris holds a member grade in the A.S.L.E. & S.A.E. He is a Lt. Col. (petroleum specialist) in the U. S. Aair Force Reserve, having served in a similar capacity during Worlld War II.

We regret to announce the death of M. F. Supy, Chief Machinist for the Kingsport Press, on Oct. 8, 1950.

Mr. Supy was an engineering graduate of Purdue University and instrumental in the organization of the Kingsport Section of A.S.L.E., serving as Vice-Chairman of the Section.

Not only A.S.L.E. and the Kingsport Section, but his many friends will keenly feel this loss.

Ernest V. Moncrieff: Former President of the Swan-Finch Oil Corp., New York City, passed away on Nov. 5, 1950. He was associated with the company for 35 years.

Mr. Moncrieff was a past President of the N.L.G.I.

CURRENT LITERATURE

Chemical Abstracts, Vol. 44, No. 15, August 10, 1950

LUBRICANTS FOR THE ARTIC. THE ORDNANCE-INDUSTRY TEAM SOLVES A VITAL PROBLEM

Powell, G. F.—p. 7052
(Ordnance, Vol. 34, 1950, pp. 242-4)

PROBLEMS OF FRICTION OF SOLIDS AND LUBRICATION

Deryagin, B. B.—p. 7052
(Vestnik Akad. Nauk S.S.S.R., No. 5, 1948, pp. 28-31)

THE WASHING OUT OF LUBRICATING OILS

Kehren, M.—pp. 7052-7053
(Melliand Textilber, Vol. 29, 1948, pp. 62-5)

EVALUATION OF THE AGING STABILITY AND MISCIBILITY OF MINERAL OILS BY MEANS OF THE NEUTRALIZATION NUMBER

Stanisavlievici, L.—pp. 7053-7054
(Schweiz. Arch. angew. Wiss. u. Tech., Vol. 16, 1950, p. 21)

No. 16, August 25, 1950

RECOVERY OF USED PETROLEUM

Volkov, E. I.—p. 7522
(Sakharnaya Prom., Vol. 20, No. 4, 1947, pp. 21-4)

MANUFACTURE OF LUBRICATING GREASES. CALCIUM EMULSION INDEX OF FATTY SUBSTANCES

Baouman, A.—p. 7523
(Industrie chimique, Vol. 37, No. 391, 1950, pp. 29-33)

TECHNICAL PROPERTIES OF MIXTURES OF SOFT SOAP WITH SYNTHETIC DETERGENTS

Reutenauer, G.—p. 7571
(Bull. mens. ITERG (Inst. tech. etudes et recherches corps gras), Vol. 4, 1950, pp. 257-62)

Chemie Ingenieur Technik, Vol. 22, Nos. 13/14, July 4, 1950

HYDRODYNAMICALLY LUBRICATED SLIDE BEARINGS (MULTIPLE SLIDE BEARINGS)

Froessel, W.—p. 297
Paper read at the DECHEMA ANNUAL MEETINGS, Frankfurt, 1950.

In the hydrodynamical lubrication, a comparatively thick lubricating film provides an intermediate layer as transmitter of the load; it effects a separation of the metal faces and has thus buoyancy properties. This type of lubrication is very advantageous because it prevents wear and tear and results in low friction; but in contradistinction to boundary lubrication it is practicable only in suitably formed oil grooves. Since hydrodynamic lubrication is based upon a flow effect initiated by the relative motion of the slides, combined with the production of pressure, an important condition is that the flowing medium, namely the lubricant, be present in abundant quantities. A multiple slide bearing has been constructed on the basis of the known rheological law.

Diesel Power and Diesel Transportation, Vol. 28, No. 9, September, 1950

MAINTAINING ENGINE TEST OIL

Anon.—pp. 57-59

Maintaining a steady flow of clean oil presents some unique problems in cleaning the oil. Filtration will do part of the job and centrifuging will do part of the job but neither filtering nor centrifuging will accomplish the desired end—completely clean oil. The logical solution to this problem would, therefore, seem to be in the combination of filtration and centrifuging to get the benefits of both systems and thus achieve the desired end. The DeLaval "Puri-Filter" which is described is just such a combination, including a De Laval centrifuge and a Fram filter.

Industrial and Engineering Chemistry, Vol. 42, No. 9, September, 1950

BOUNDARY LUBRICATION OF STEEL. BLENDS OF ACIDS, ESTERS, AND SOAPS IN MINERAL OIL

Davey, W.—pp. 1837-1841

Boundary lubrication of steel by blends of acids, esters, and soaps in mineral oil has been studied by means of the four-ball machine. Acid blends reduce friction by physical adsorption of the acid and reduce wear by formation of soap films of low shear strength. Esters are less effective in wear reduction since soap formation can occur only under very extreme conditions. Metal soap blends are most effective in boundary lubrication if metal interchange between soap and iron can occur. Addition of sulfur markedly improves the lubricating properties of acid, ester, and soap blends.

EXTREME PRESSURE LUBRICANTS. PHOSPHORUS COMPOUNDS AS ADDITIVES

Davey, W.—pp. 1841-1847

The extreme pressure properties of some phosphorus compounds, blended in mineral oil, alone, and in the presence of fatty acids, or esters, or sulfur, have been assessed by the four-ball machine. Phosphites are superior to phosphates as extreme pressure additives and alkyl esters are superior to aryl esters. The addition of fatty acids, esters, or sulfur improves the extreme pressure properties of blends of phosphites and phosphates. The extreme pressure properties of some chlorinated phosphites and phosphates have been studied and were found to possess excellent lubricating properties and to be active at low concentrations. The mechanism by which phosphorous compounds reduce friction and wear has been studied.

Industry and Power, Vol. 59, No. 3, September, 1950

ADDING GRAPHITE TO OIL IMPROVED ENGINE PERFORMANCE

Anon.—p. 110

Roadtests on a Plymouth automobile, run over 235,000 miles showed that the addition of colloidal graphite to engine oil resulted in an average saving of 30% in oil and 10% in gasoline. The principle is applicable to any internal combustion engine. Colloidal graphite particles, unctuous and microscopically fine, adhere tenaciously to metal cylinder walls and bearings to a greater degree than plain oil. A "graphoid" film is formed that is difficult to wipe dry. This surface will supposedly support a thinner film of lubricant without rupture than will the metal alone. However, if a rupture should occur, metal-to-metal contact is avoided by the film.

Institute Spokesman, Vol. 14, No. 6, September, 1950

THE STORY OF A NEW GREASE

Bright, G. S.—pp. 11-16

Greases are fundamentally thickened oils, and in the great majority of cases, are oils thickened with soaps of some type. They are not, however, simple mixtures. Rather, they are exceedingly complex physico-chemical systems. Fatty materials may be grouped in a variety of ways but for the purposes of grease manufacture they may be classed as natural fats (glycerides), fatty acids, modified fats and fatty acids (as, for example, hydrogenated fats), fractionated fatty acids, and synthetic materials. For grease manufacture, calcium, sodium, aluminum, and lithium soaps are most commonly used. For special purposes, however, or to impart special characteristics, soaps of barium, strontium, magnesium, lead, copper, other metals, and of organic bases may be used. Calcium soap greases are normally buttery in texture although they can be made stringy or tacky by proper choice of ingredients. Their outstanding characteristic is that they are highly water resistant and can be used successfully under extreme water conditions. Sodium soap greases have less water resistance than calcium soap products but have much better high temperature characteristics, and give much better rust protection. Aluminum soap greases have received some approval for a variety of uses, although they have never gained as general acceptance as the sodium and calcium soap greases. Lithium soap greases have good water resistance, good high temperature characteristics, and a buttery to semi-buttery texture, but require special manufacturing procedures and high cost ingredients which prohibit their use in all applications where cost is a limiting factor.

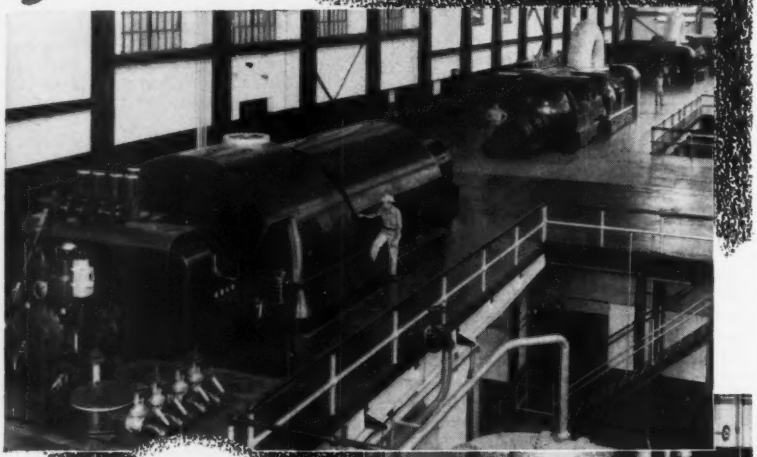
Journal of Commerce, New York, Vol. 225, No. 17,222, Tuesday, September 5, 1950

NEW SYNTHETIC LUBES FINDING WIDENING USES

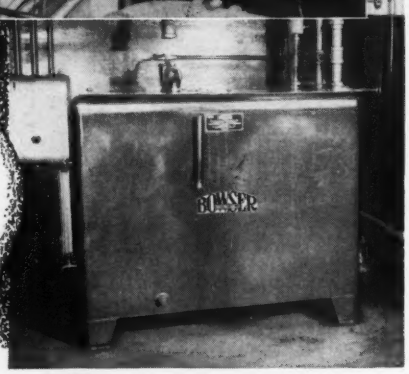
Millett, W. H.—p. 23

The polyalkylene glycol lubricants represent an entirely new type of lubricant. These synthetic fluids are marketed under the trade-mark "Ucon." They are produced from starting materials which can be readily prepared from natural gas or cracked petroleum hydrocarbons. There

Longer life for Turbine Bearings



The bearings of these 40,000 KW turbine generators are insured against bearing failure by Bowser oil conditioners.



Stop THESE 6 ENEMIES OF TURBINE OIL NOW....

1. Turbulence
2. Air Entrainment
3. Moisture Contact
4. Heat
5. Metallic Contact
6. Removal of Inhibitors

When turbine bearings "stay-on-the-job," costly shutdowns are avoided and less standby equipment is required.

• • •

Write today for your copy of this new bulletin on the improved Bowser method for conditioning turbine oils.

BOWSER, INC., 1358 Creighton Avenue, Fort Wayne 2, Ind.

LIQUID CONTROL SPECIALISTS SINCE 1885

are two recent developments which are of particular interest. One of these is the formulation of a series of lubricating greases that are characterized by the same performance-wise superiority as characterizes the fluid lubricant. These greases have been found to be particularly suited for use at extremes of high or low temperature.

Journal of the Institute of Petroleum, Vol. 36, No. 319, July, 1950

CHARACTERISTICS OF GREASES AS RELATED TO ANTIFRICTION BEARING APPLICATIONS
Carmichael, E. S. and Robinson, R. C.—p. 327A
(Mech. Engng, Vol. 72, (2), Feb. 1950, p. 137)

Lubrication, Vol. 36, No. 9, September, 1950

GREASE APPLICATION DEVICES
Anon.—pp. 97-112

The article tells about the development of grease application devices. The pressure gun, spring type grease cups, the power driven grease lubricator, pressure lubricators, multiple tube and floor level lubrication, and centralized pressure grease lubrication are covered. Mechanisms supplying definitely known quantities of grease, pumpability characteristics, air-operated test equipment, the test conditions and results, correlation of pumpability with the pressure viscosimeter, hand gun test equipment and results, and centralized lubrication system and results, are discussed.

Lubrication Engineering, Vol. 6, No. 3, June, 1950

PUMPING CHARACTERISTICS OF AN 180-DEGREE JOURNAL BEARING
Roach, A. E.—pp. 122-125

Although the ability of a journal bearing to function as a pump when a hole is drilled through it into the high-pressure oil film was observed as early as 1883 by Beauchamp Tower, this aspect of bearing operation appears to have subsequently attracted little interest. The use of a bearing as a pump might be attractive, however, in special instances where a small quantity of high-pressure oil is desired but where it is not economically feasible to install a separate pump; pumping duty might then be imposed as an additional duty upon an existing bearing. A discussion follows.

FACTS YOU SHOULD KNOW ABOUT INDUSTRIAL GREASES
Anon.—p. 133
(Our Sun—Sun Oil Co., Vol. 14, No. 2, Spring Issue. pp. 20-21, 1949)

Many millions of pounds of lubricating greases were shipped each year from the Company's refinery at Marcus Hook. Each grease is a combination of mineral oil with some other material, usually soap (fats), so a comparatively soft oily material can be obtained. It is possible to place greases into a number of broad classifications. One such division would refer to general purposes, that is, industrial greases as distinguished from automotive greases. The Company manufactures both kinds in a number of types, with railroad and marine greases, considered part of the industrial line. Another broad classification refers to the general type of grease resulting from the kind of soap base or thickener compounded with the lubricating oil in grease manufacture—sodium (soda) base greases from the use of sodium, and calcium

(lime) base greases from the selection of calcium or lime soap in the product's make up. Still another division possible would be according to texture of finished greases. Sun's lime base greases are usually employed on industrial equipment where the operating temperatures are normal. The Sun line of sodium base greases finds industrial usage where higher temperatures are encountered.

Mechanical Engineering, Vol. 72, No. 5, May, 1950

DIESEL-LUBRICATION TESTS
Anon.—pp.405-406

The article, by Conn, E. L., and Robie, T. M., in which oil maintenance and purification problems connected with Diesel engines, is reviewed. The testing of two types of Diesel engines (Model 38 and Model 31) on the Diesel test floor of Fairbanks, Morse and Company, Beloit, Wis., is described. The design of these engines is such that the same lubricating oil may be used for testing all of them. Test procedure and the equipment such as filter presses oil purifiers of the active earth-filtering type, are covered The results obtained are discussed. The article was read before the 1949 ASME Annual Meeting, held in New York.

No. 6, June, 1950

OIL HOLES AND GROOVES IN PLAIN JOURNAL BEARINGS
McKee, S. A. and White, H. S.—pp. 505-506

Data are presented showing the performance of plain journal bearings having various arrangements of oil holes and grooves operating in a four-bearing friction machine with forced-feed lubrication. Tests cover operation where the oil is fed through the bearing shell by means of five arrangements, including one, two, or four oil holes; one axial or one circumferential groove. The paper (ASME, No. 50-S-9, paper) was presented at the 1950 ASME Spring Meeting.

No. 9, September, 1950

THE EFFECT OF THE CUTTING FLUID UPON CHIP-TOOL INTERFACE TEMPERATURE
Shaw, M. C., Pigott, J. D. and Richardson, L. P.—p. 747

AN ANALYTICAL EVALUATION OF METAL-CUTTING TEMPERATURES
Trigger, K. J. and Chao, B. T.—p. 747

Both papers were presented at the 1950 ASME Semi-Annual Meeting. First paper. An analysis is presented of the short-circuiting effect of a cutting fluid in conjunction with chip-tool interface temperature measurements by the tool-work thermocouple technique. The second paper presents an analytical method for the determination of metal-cutting temperatures.

Oil and Gas Journal (Gulf Coast Number), Vol 49, No. 7, June 22, 1950

NEW LUBE CLASSIFICATION
Weber, G.—p. 155

A new, simplified viscosity classification for crankcase lubricating oils is in the last stage of official approval. Agreement has been reached by a committee of the Society of Automotive Engineers. The new classification lists seven viscosity grades. The proposed new classification is as follows:

(*Continued on page* 292)

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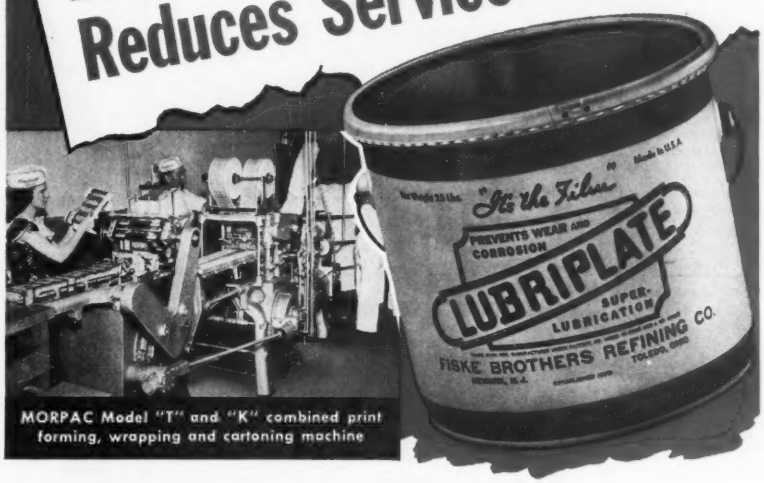

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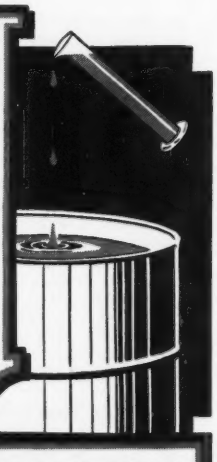

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OILS AND LUBRICANTS

PATENT ABSTRACTS

Printed copies of patents are available from the Patent Office at twenty-five cents each. Address the Commissioner of Patents, Washington, D. C., for copies and for general information concerning patents.

From Official Gazette—Vol. 638, Nos. 1, 2, 3, 4; Vol. 639, Nos. 1, 2, 3, 4, 5.

Prepared by ANN BURCHICK

Aluminum Soap Greases—Patent #2,521,395—Arnold J. Morway and Alan Beerbower, assignors to Standard Oil Development Co.

A lubricating grease composition consisting essentially of 91 to 93% by weight of mineral lubricating oil, 6 to 7% aluminum stearate, 0.6 to 1.2% of hydrogenated fish oil acids which are substantially saturated fatty acid having 12 to 22 carbon atoms per molecule, and 0.6 to 0.7% isooctyl phenol.

Grease Composition—Patent #2,521,438—John C. Zimmer and Arnold J. Morway, assignors to Standard Oil Development Co.

A low temperature grease composition consisting essentially of 20 to 40% by weight of mineral lubricating oil, 45 to 65% by weight of an ester having the general composition $COOR_1(R)COOR_2$ wherein R is a bivalent aliphatic hydrocarbon radical and R_1 and R_2 are branched chain hydrocarbon radicals, 5 to 30% of a soap selected from the group consisting of the alkali and alkaline earth metal soaps, and 0.1 to 5% of amphoteric metal soap as a stabilizer.

Lubricating Compositions — Patent #2,522,155—Seaver A. Ballard, Rupert C. Morris, and John L. Van Winkle, assignors to Shell Development Co.

A lubricating composition comprising as the major lubricating constituent thereof a mixture of linear polymers of glycidyl isopropyl ether having a molecular weight of about 773 and a nitrogen content of about 0.15% said nitrogen content being contained in di-isopropylamino end groups attached to polymeric members of said mixture, and a minor amount, sufficient to stabilize said mixture against oxidation, of phenyl-alpha-naphthylamine.

Antioxidants for Mineral Oil Lubricants and Compositions Containing the Same—Patent #2,522,312—Herschel G. Smith and Troy L. Cantrell, assignors to Gulf Oil Corp.

The process of preparing an addition agent for mineral oil lubricants which comprises heating triphenylguanidine with from 4 to 9 mols of N-dimethylaniline and 4 to 9 mols of formaldehyde per mol of triphenylguanidine in the presence of an activated clay catalyst at a temperature not in excess of 350 F. to condense together the three reactants, and recovering the condensation product.

Mineral Oil Containing a Copolymer of an Aliphatic Monoolefin and Dihydronapthalene—Patent #2,522,455—Eugene Lieber, assignor to Standard Oil Development Co.

A lubricant comprising a major proportion of a mineral lubricating oil base stock containing dissolved therein about 0.1 to 10% by weight of a copolymer prepared from 80 to 99 parts by weight of an aliphatic monoolefin containing from 3 to 5 carbon atoms and 20 to 1 parts by weight of dihydronaphthalene, said copolymer being copolymerized at a temperature below 0 C. in the presence of a Friedel-Crafts catalyst and having a molecular weight within the range of 2,000 to 30,000.

Lubricating Grease Composition—Patent #2,522,460—Arnold J. Morway and Alan Beerbower, assignors to Standard Oil Development Co.

A lubricating composition consisting essentially of 66 to 94% mineral lubricating oil, 5 to 30% of a metal soap selected from the group consisting of the soaps of fats and fatty acids, and 2 to 4% of a modified channel carbon black having a pH of about 9, a particle size, from 20 to 100 millimicrons, and a structure index of about 200.

Preparation of Synthetic Lubricant—Patent #2,522,512—Denham Harman and William E. Vaughan, assignors to Shell Development Co.

The process which comprises heating hydrogen sulfide and diallyl ether in the presence of a minor amount of di-tertiary-butyl peroxide at a temperature from 40 to 150 C. for a period between one and 48 hours and removing from the mixture of polymeric adducts so formed the fraction volatilizing below 160 C. at 1 cm. mercury pressure.

Solvent Refining of Fatty Oils—Patent #2,523,630—Herbert J. Passino, assignor to The M. W. Kellogg Co.

In the solvent fractionation of a high molecular weight mixture containing a fatty oil by means of a solvent whose critical temperature is not higher than 450 F. wherein the solvent is introduced at a low point in a vertical solvent fractionation zone and the high molecular weight mixture is introduced at a point substantially above the solvent charging point, and wherein the solvent fractionation treatment is carried out at temperatures in the range between the critical temperature of the mixture and 100 F. below the critical, and in which miscibility of the high molecular weight mixture and the solvent decreases with rising temperature, the improvement comprising withdrawing raffinate solution from a point below the point of introduction of the high molecular weight mixture, and reintroducing a portion of said withdrawn raffinate into said solvent fractionation zone at a point above the point of introduction of said solvent, and not higher than the point of introduction of said high molecular weight mixture.

Metalworking Lubricant—Patent #2,524,017—Robert T. Hance and Harold C. O'Brien, Jr., assignors by mesne assignments to Cincinnati Milling Machine Co.

A coolant composition for operations such as cutting, grinding and the like, said coolant having a continuous aqueous phase and a normally solid disperse phase, the particles of said disperse phase being in colloidal condition and exhibiting a Brownian movement, the disperse phase comprising a normally solid paraffin wax having a melting point lower than 100 C., a water-soluble sulphonated oil dispersing agent for dispersing said wax into said colloidal condition and a stabilizing agent which is stearyl alcohol to maintain the stability and homogeneity of said colloidal dispersion.

Lubricant—Patent #2,524,563—Theodore W. Evans and Richard Whetstone, assignors to Shell Development Co.

A lubricating grease comprising, as substantially the sole lubricant present, a major amount of a liquid polymerized ester of a saturated monocarboxylic having between 5 and 12 carbon atoms and an unsaturated aliphatic monohydric alcohol having between 3 and 8 carbon atoms, said polymerized ester having a minimum boiling point above 100 C. at 2 mm. mercury pressure, and a minor amount of an alkali metal soap sufficient to form a uniform grease structure.

Purification of Oil—Patent #2,525,702—Morris Mattikow, assignor to Benjamin Clayton, doing business under the fictitious name and style of Refining, Unincorporated.

The process of degumming crude glyceride oils, which comprises, admixing with said oil an aqueous degumming agent containing in solution a non-volatile, water-soluble, organic non-soap synthetic detergent as a wetting agent to hydrate the gums contained in said oil and render them insoluble in said oil, and thereafter centrifugally separating an aqueous phase containing the hydrated gums from said oil.

Hydrocarbon Oil Lubricant Containing Di-Tertiary-Alkyl Sulfides—Patent #2,526,041—John F. Olin, assignor to Sharples Chemicals Inc.

An improved lubricant comprising a major proportion of a hydrocarbon oil and a minor but sufficient proportion to stabilize the hydrocarbon oil against oxidation, of an added organic sulfide compound comprising di-tertiary dodecyl disulfide.

Lubricant Composition—Patent #2,526,490—Eugene Lieber, assignor to Standard Oil Development Co.

A product having good solubility in highly paraffinic mineral lubricating oil, said product consisting essentially of a resin produced by resinification of one mol of an alkyl phenol having 4 to 6 carbon atoms in the alkyl group, with about ½ to 2 mols of a lower saturated aliphatic aldehyde having 1 to 3 carbon atoms, in the presence of ½ to 5 volumes of inert solvent per volume of reactants, and in the presence of about 10 to 150 parts by weight of aluminum chloride catalyst per 100 parts by weight of alkyl phenol, using a final reaction temperature of 125 F. to 300 F., said resin being substantially non-volatile under reduced pressure up to 600 F.

Turbine Oil Composition—Patent #2,526,755—Herman D. Kluge and Edwin C. Knowles, assignor to The Texas Company.

A mineral lubricating oil composition comprising as the predominant constituent a lubricating oil normally susceptible to deterioration by oxidation in the presence of water, and about 0.01-3.0% by weight based on the weight of the oil of a 2-hydroxy 3-tert.-butyl 5-methyl benzyl tert.-alkyl sulfide effective to stabilize said oil against said deterioration by oxidation in the presence of water, said tert. alkyl group containing from 4 to 6 carbon atoms.

Color and Viscosity of Lubricating Oils—Patent #2,526,931—Paul H. Carnell, assignor to Phillips Petroleum Co.

The process of manufacturing a lubricating oil of improved color and viscosity index, which comprises treating a lubricating oil with a mixture of substantially anhydrous hydrofluoric acid and at least one molybdenum sulfide, the ratio of hydrofluoric acid to oil being in the range of about 1:20 to about 20:1, and the quantity of molybdenum sulfide being in the range of about 5 to about 20 weight per cent of the oil being treated, said treatment of lubricating oil taking in the range of about 100 to about 300 C. at a pressure sufficient to maintain the oil and hydrofluoric acid in liquid phase which is in the range of about 500 to about 1500 psi, for a period of time within the range of about 180 minutes, cooling said mixture of oil, hydrofluoric acid, and molybdenum sulfide, introducing a light-paraffin to break the acid-oil emulsion, and recovering an improved lubricating oil as a product of the process.

Use of Olefin Polymer Oil for Grease Manufacture—Patent #2,526,986—William B. Whitney, assignor to Phillips Petroleum Co.

An improved lubricant comprising essentially between 30 and 95 per cent by weight of at least one polymer, in the viscosity range above SAE 30 lubricant to 20,000 SUS at 100 F., produced by treating at least one aliphatic mono-olefin having between three and five carbon atoms per molecule with a tetrahalide of a group IV element having an atomic number between 14 and 50 under polymerization conditions; and between 5 and 70 per cent by weight of a soap of a fatty acid selected from the group consisting of sodium, lithium, calcium, and aluminum soaps.

Foam Inhibited Oils—Patent #2,528,465—Victor N. Borsoff and James O. Clayton, assignors to California Research Corp.

A compounded lubricating oil comprising a petroleum lubricating oil, containing an oil soluble metal salt selected from the group consisting of polyvalent metal phenates and polyvalent metal salts of organo substituted acids of phosphorus, and in an amount sufficient substantially to increase the tendency of the lubricating oil to foam excessively at temperatures above about 150 F., and under conditions of severe oil agitation and intermixture with gas, and a small amount, sufficient to inhibit foaming of the oil, of an alkoxy phenol which contains not less than 15% by weight of oxygen and has a molecular weight not higher than 270.

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(*Continued from page* 283)

also be used in making press fits or metal-to-metal fits, and on threads of bolts, nuts, studs, and so forth.

Literature and prices may be had by writing the above manufacturer.

Compound Oil: Gulf Oil Corp., 17 Battery Pl., New York, N. Y.—This compounded spindle oil for use in textile mill lubrication, called "Gulfspin," has been developed as a result of extensive research. The oil is specifically designed to keep textile spindle blades and bolsters clean while reducing friction and power consumption.

It is claimed that no increase in viscosity is apparent while in service. The oils are said to have good rust proof characteristics and to carry greater loads then straight mineral oils, consequently reducing wear.

Precision Rings: Frederick S. Bacon Laboratories, 192 Pleasant St., Watertown 72, Mass.—The above laboratories are now manufacturing Precision O-Rings that are said to provide hydraulic seals resistant to petroleum oils and most hydrocarbons with outstanding efficiency under static conditions at either low or high temperatures. The rings molded from a mixture of silicone rubbers, are available at present in semi-commercial quantities and in a limited number of small sizes.

Complete data sheet on O-Rings, including available sizes and prices, may be secured by writing Dept. O-Ri at the above laboratories.

Technical Bulletin: Sun Oil Co., 1608 Walnut St., Philadelphia 3, Pa.—"Hydraulic Fundamentals and Industrial Hydraulic Oils"—Technical bulletin B-4 is available without cost by writing the above company. It carries information on hydraulic systems, maintenance, trouble-shooting and the selection of proper fluids; acting as a valuable training aid or guide for maintenance supervisors, operators and apprentices.

Jim Hopkinson, Pres. of Penn-Petroleum Corp., and Chairman of the National Membership Committee, will be in charge of the ASLE Booth at the Plant Maintenance Show (page 274). Why not drop in?

CURRENT LITERATURE

(*Continued from page* 287)

S.A.E. Vis. No.	Viscosity range, Saybolt Universal, seconds —0° F.— Min.	Max.	—210° F.— Min.	Max. (less than)
5W	.....	4,000	..	...
10W	6,000	12,000	..	...
20W	12,000	48,000	..	...
20	.....	... ..	45	58
30	.....	... ..	58	70
40	.....	... ..	70	85
50	.....	... ..	85	110

No. 16, August 24, 1950

WATER-SOLUBLE CUTTING OILS AS PICKLING INHIBITORS
Hager, K. F. and Rosenthal, M.—pp. 142-143, 145

Normal procedure for derusting equipment that is to be rehabilitated is to treat the parts in an inhibited acid pickling bath. Sulfuric acid to which an inhibitor has been added is the commonest pickling acid employed. Investigations of acid pickling inhibitors at this laboratory have led to the findings that most commercial water-soluble cutting oils are efficient inhibitors against acid attack of the base metal and, in addition, give a temporary protection against rerusting to the freshly pickled, highly active, metal surface.

No. 18, September 7, 1950

EFFECTIVENESS OF ADDITIVES IN VARIOUS KINDS OF OILS
Nelson, W. L.—pp. 88, 92

A list of additive types available for compounding with lubricating oils, as well as the characteristics which would be changed by these additives, reveals that there are approximately 51 characteristics of lubricating oils which can be affected by additives. A most important variable is the degree and kind of refining that the oil has undergone. Even the kind of gasoline used in the engine may be significant. Gasolines which exhibit a large difference in octane number by the motor and research methods are apt to cause the formation of more engine deposits.

Petroleum, Vol. 13, No. 5, May, 1950

THE LUBRICATION OF BALL AND ROLLER BEARINGS
Sansom, T. B.—pp. 112-114

The important part played by lubrication in transmitting work and energy into rotary motion by means of ball and roller bearings is stressed. The author discusses the principles of lubrication, functions of the lubricant, fluid friction, and application of a lubricant.

THE CONTINUOUS MANUFACTURE OF GREASE
Bloomsberg, H. E. and Beerbower, A.—pp. 115-118, 120

Commercial production on a continuous basis of calcium soap grease has been started in the U. S. A. The full-scale operation which is discussed consists, in essence, of three basic steps: (1) Calcium grease base manufacturing and handling; (2) oil storage, blending and delivery to the grease manufacturing unit; (3) continuous blending of the calcium grease base and oil to produce cup and chassis grease. Additional equipment for the continuous operation includes consistency control of the product, packaging and shipping of the finished greases and the continuous blending of extreme pressure lubricants. Recent improvements, pilot plant studies, and continuous blending of additives in lubricating oil are covered.

RE-REFINING USED AIRCRAFT OILS
Anon.—p. 119

An interesting method of cutting down consumption of expensive lubricants has been adopted by American Airlines, one of the largest air transport companies in the U. S. A. By re-refining used aircraft engine oil, during one year approximately 85,000 gallons of oil have been salvaged and some 40,000 gallons of petroleum solvents have been reclaimed. The difference between re-refining and reclaiming is explained. The technique used and the results obtained are described.

NEW GREASE INGREDIENT
Anon.—p. 126

A polyunsaturate-free fatty acid known as Lubrex 45, which has been developed specifically for use in grease manufacturing, was recently announced in the United States. The fatty acids in this product are said to be stabilized, thus giving greater resistance to heat discoloration. Freedom from polyunsaturated fatty acids obviates rancidity or gum formation which usually develops from excess saturation. The melting point is controlled at 45° C, and color and uniformity are subjected to laboratory analysis as each batch is produced.

No. 9, September, 1950

TRANSPARENT BEARING
Anon.—p. 238

To permit the observation of oils and greases in bearings under varied loads and speeds a transparent plastic bearing has been introduced. By adding a bright red dye to the lubricant its line of flow can be followed. The friction drag is measured by the sensitive scales on the test machine and operating temperatures are gaged by means of thermocouples and a potentiometer. It is said that the machine can be adapted to study ball and roller bearings as well as plain journal bearings.

ALL-PURPOSE LUBRICANT
Anon.—p. 238

A lubricant said to contain no metallic soaps or fatty acids has recently been introduced. Known as Plastilube, this all-purpose lubricant has no melting point. Various reaction products of montmorillonite and organic cations are used for thickening the oil. These reaction products form a physical gel with petroleum oils and do not depend upon the matrix to hold the oil. A change in phase from solid to liquid will not, therefore, occur. This product is said to possess good adhesive qualities, to pump well at low temperature and not to break down during working.

Petroleum Engineer, Vol. 22, No. 9, August, 1950

WORK GREASES
Anon.—p. C-42

WATER-PROOF GREASE
Anon—p. C-42—C-43

First note. Lubricating greases are "worked" primarily because, by so doing, a more reliable measure of the consistency is obtained than if an "unworked" test were made. Since it is impractical always to take the consistency of a grease in the original container, the product is disturbed in transferring to a cup in which such a test is to be made. By specifying 60 double strokes in a standard grease worker before a test is made for consistency, the irregularities due to variations in handling by different operators are equalized. The standard method for this test (A.S.T.M.—D 217) calls for completion of 60 full double strokes of the perforated discs in about one minute. Second note. A lubricating grease that will give satisfactory service when used in contact with water should be one that does not emulsify or thin out to such an extent that it will be removed from the bearing surface. Probably the best test for resistance to the action of water is one called for in certain government specifications such as AN-G-15a. The test is described. The reference is given: Klemgard, Manufacture of Lubricating Grease, Rheinhold Publishing Company, 1937, where a formula is given for a waterproof lubricating grease made from fatty acids rather than fat.

No. 10, September, 1950

HIGH VERSUS LOW MELTING POINT GREASES
Anon.—pp. C-18—C-20

For general lubrication a high melting point lubricating grease is more desirable than a low melting point lubricating grease because many points of application operate at temperatures above that at which a low melting point product would be satisfactory. Further, the former lubricant provides a greater factor of safety. The terms high-and low-melting are relative. The standard method, for determining the characteristic in question, as described by the ASTM (D 566-42) employs the term Dropping Point rather than melting point and states that this "is the temperature at which the lubricating grease passes from a semisolid to a liquid state under the conditions of the test." The action or loss of "peptizers" which act as fluxes may change the phase of the soap and influence the softening of the grease.

Power, Vol. 94, No. 9, September, 1950

BEING PRACTICAL ABOUT OIL VISCOSITY
Anon—p. 117

There is a basic difference in lubrication principle between plain and anti-friction bearings. This fundamental divergence should be understood before discussing oil viscosity in connection with lubrication of anti-friction bearings. Allowing reasonable amount of "looseness" when selecting oil viscosities for anti-friction bearings, falls in line with the well-founded trend toward using the one lube for many jobs. The article deals with bearing requirements and viscosity recommendations.

Scientific Lubrication, Vol. 2, No. 6, June, 1950

SPECIAL HEAVY DUTY OILS
Anon.—p. 26

The use of heavy duty oils in diesel engines, particularly those engaged upon arduous duties, is acknowledged generally to be economical procedure. The reduction of engine deposits such as piston varnish and lacquer, the freedom of piston rings and general engine cleanliness are the principal items that provide longer periods between engine overhauls resulting in reduced maintenance costs. Whether the increased deposits so frequently found are due to engine design, fuel or other causes, lubricating oil chemists have always considered that it might be possible to reduce their effects by paying increased attention to the chemical

qualities of the oil. The case for these "high additive" type oils is therefore only concerned, at present, with diesel engines that are either engaged on very heavy duty service or are using high sulfur content fuel. These oils have been given the title Special Heavy Duty Oils. By detailed study of the oxidation, anti-corrosion and detergent properties of chemical compounding agents, first singly and then in combination, it was found possible so to balance massive doses of additives in a lubricating oil that a vastly extended horizon of engine protection was created. Specifically, in diesel engines, the Special Heavy Duty oil nullified the corrosive cylinder wear which theretofore had resulted from the use of sulphur-bearing fuels and/or from conditions of operation. In addition piston fouling was corrected.

FIRST PRINCIPLES; A SERIES OF ARTICLES EXPLAINING IN SIMPLE LANGUAGE THE FUNDAMENTALS OF LUBRICATION NO. 11. OXIDATION.
Anon.—pp. 31-32

The article takes up: Early oxidation tests, factors affecting oxidation, oxidation and carbon residues, the air ministry oxidation test, failings of oxidation tests and oxidation at low temperatures.

Vol. 2, No. 7, July, 1950

LUBRICATION — AN AID TO PREVENTIVE MAINTENANCE
Jordan, G. D.—pp. 10-13

The author discusses the application of lubrication to planned maintenance, and illustrates this by examples of methods adopted during practical experience in a large steel mill.

GREASE LUBRICATION FOR RAILWAY JOURNAL BEARINGS
Anon.—p. 22

FIRST PRINCIPLES; A SERIES OF ARTICLES EXPLAINING IN SIMPLE LANGUAGE THE FUNDAMENTALS OF LUBRICATION NO. 12. DEMULSIBILITY
Anon.—pp. 26-27

This is one of a series of articles explaining in simple language the fundamentals of lubrication. Demulsibility, steam emulsion test, interfacial tension, etc., are taken up.

No. 8, August, 1950

LUBRICATION OF MECHANIZED FARM EQUIPMENT
Anon.—p. 9

OIL RETAINING BEARINGS
Anon.—pp. 10-13

The importance of self lubricating bearings in modern industry, particularly in connection with mass production methods, has aroused increasing interest. The information has been provided by Bound Brook Bearings (G.B.) Ltd., who have recently moved to their new factory at Trent Valley Road, Lichfield, Staffs., where the whole premises are devoted to the design and manufacture of "Compo" oil retaining bearings. The "Compo" bronze bearings manufactured by the Bound Brook Bearing Company consist of the 90/10 anti-friction bronze, i. e., 90% copper and 10% tin. Porosity is achieved by virtue of the inter-connecting channels and reservoirs which make up the structure of the material, and result in an oil retention capacity of anything from 25 to 35% of the volume of the bearing.

PLANT SURVEYS AND THE LUBRICATION ENGINEER
Redgrove, E. R.—pp. 15-18

AUTOMATIC LUBRICATION OF SLAT CONVEYOR CHAINS
Weatherall, R.—pp. 19-20, 26

BEARING MATERIALS, LUBRICATION AND OIL GROOVES
Warburton, H.—pp. 22-23

The most frequent source of bearing failure is insufficient or incorrect lubrication. When full fluid lubrication has been established, the composition of the bearing metal is of little consequence so long as it be of the requisite strength. Solidified oils and greases are effective lubricants for bearings that must withstand exceptionally heavy pressures. Causes of bearing failure may be due to design, workmanship, excessive friction, or less frequently, error in selecting the lining material. Graphite as a constituent is taken up. A lead-base bearing metal, having even a small proportion of colloidal graphite as one of its ingredients, possesses special properties of self-lubrication.

CONFERENCE ON THE PHYSICS OF LUBRICATION
Anon.—p. 24

A Joint Conference on the Physics of Lubrication was recently arranged by the Manchester and District Branch of The Institute of Physics, and the British Rheologists Club. The Conference was held at Manchester University and its object was to review the physical aspects of lubrication and to discuss recent advances in this field.

SOME USES FOR & PROPERTIES OF E. P. GREASES
Williams, A. E.—pp. 25-26

Some valuable characteristics of extreme pressure greases are absence of channelling at low temperatures, no tendency to corrosion or abrasiveness, maintenance of homogeneity under all service conditions, ample capacity to carry the maximum loads and resistance to rupture under high pressures.

FIRST PRINCIPLES; A SERIES OF ARTICLES EXPLAINING IN SIMPLE LANGUAGE THE FUNDAMENTALS OF LUBRICATION. No. 13. POUR POINT
Anon.—pp. 32-33

The majority of lubricating oil specifications call for a maximum pour point. This is the lowest temperature at which the oil will pour or flow when it is chilled without disturbance, under prescribed conditions. The use of modern chemical additives, however, makes it possible to provide an oil with an extremely low pour point without affecting any important lubricating properties. The method of ascertaining the pour point is to cool a sample of oil, slowly, and find the highest temperature at which it will not pour from its receptacle. Apparatus for determining pour point is described. The same apparatus is used for determining cloud point.

Service Factor (Sinclair Refining Co.), Vol. 15, first edition 1950

MARINE LUBRICATION
Anon.—pp. 1-5

This issue of The Service Factor covers the lubrication of marine engines, turbines and other machinery and recommends suitable Sinclair lubricants. A general marine lubrication chart is included.

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LUBRICATION DAN SEZ:

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in these 74 years— tremendous experience, constant laboratory research, close study of industrial lubricant problems have resulted in the development of

*** LEADOLENE Klingfast**

. . . and one of our good customers recently DISCOVERED that they had better protection, and the consumption of Leadolene KLINGFAST was just *one-fifth* the quantity of a high grade lubricant they had been using previously—on enclosed table roller gear housings of a continuous plate mill. Leadolene KLINGFAST *can do a better protective job for you, too, more economically,* under such difficult conditions as climatic changes, excessive water and abrasive conditions. Our engineers will be glad to work with you.

CHECK THESE 9 IMPORTANT FACTS:

1. **EXTREME PRESSURE pH-ilm STRENGTH** of 50,000 lbs. per square inch minimum by "Timken" testing machine.
2. **ADHESIVENESS** in which affinity for steel and other metals develops maximum adhesion and prevents drippage or creeping. Retains a flexible coating in nature.
3. **WATER REPELLENCE** which retards washing off, creates a lubricating pH-ilm under moisture or water conditions.
4. **CORROSION PREVENTION** is an excellent protective coating in that it will not etch or corrode metals. Is never acidic.
5. **COMPOUNDED STABILITY**—Will not bleed or change physical condition within range of higher than usual temperatures for this type of lubricant.
6. **LOW TEMPERATURE FACTORS**—While having a solidifying action by decreased temperature as low as —40 F., it does not harden, crack or decrease in adhesion. The flexible coating withstands distortion of the application.
7. **ABRASIVE RESISTANCE**—Extremely high for a lurbicant. Does not wipe off nor will be removed in handling by workmen's hands or gloves. Is extremely repellent to adhesion of scale, metallics and other forms of dusts or contamination.
8. Klingfast has remarkable corrosive resistance to salt or sea water, acidic vapors and solutions.
9. Klingfast can be removed by ordinary solvents such as kerosene, gasolene, naphtha, carbon tetrachloride and similar substances but is highly impervious to lubricating oils and greases.

*LEADOLENE . . . the "I. P. Lubricant" (Indestructible pH-ilm) . . . for Industrial Needs

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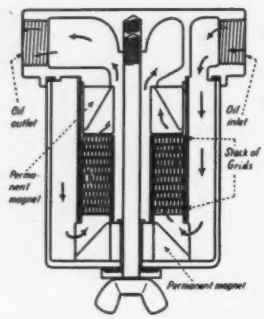
HOW
MAGNETIC FILTERING

extracts steel and iron particles from suspension in oil — even as small as a micron in size

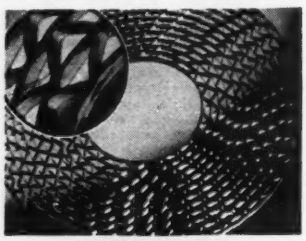


The **FRANTZ** Permanent Magnet **FERROFILTER** installed in the lubricating oil system prevents abrasive damage to the smooth surface of bearings and gears. It magnetically extracts the steel and iron particles from suspension in the oil, thereby extending the life of bearings and all wearing surfaces.

The cross section shows how the **FERROFILTER** works: Oil enters the space around the magnets and flows inward through channels in the lower magnet. Although offering very little resistance to the flow, the hundreds of feet of strongly magnetized grid edges comb and re-comb the liquid, splitting the flow stream into thin elements and forcing each particle of iron, steel, scale, core-sand, etc., to pass very close to the grid edges which attract and hold the magnetic particles, giving an extremely high efficiency of removal.

The **FRANTZ** Permanent Magnet **FERROFILTER** represents the most advanced product of its kind ever developed. It is doing an outstanding job in hundreds of plants both large and small. There are six sizes, from ⅜" to 3" pipe size.

Our bulletin No. 50 gives complete information. Why not write for it now.



A FERROFILTER GRID
Magnified inset shows particles on collected grid edges.

FRANTZ FERROFILTER

- Catches ferrous particles as fine as one micron
- No replacement parts to buy
- Full flow and non-clogging
- Easily attached
- All parts easily accessible and quickly cleaned

S. G. FRANTZ CO., INC.

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6,154,648 tons of steel rolled on this bearing lubricated by Farval

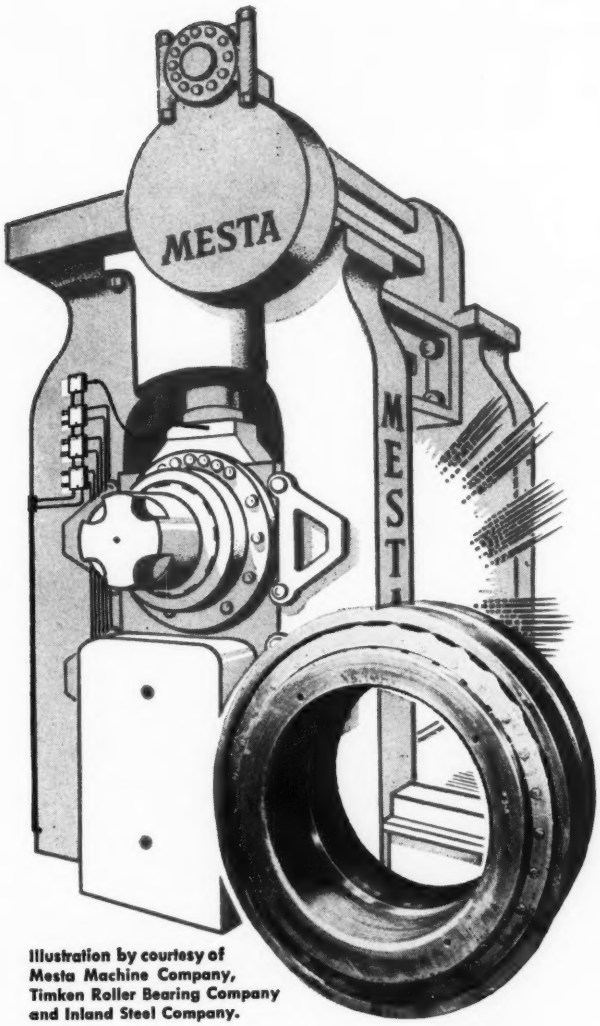


Illustration by courtesy of Mesta Machine Company, Timken Roller Bearing Company and Inland Steel Company.

FARVAL—*Studies in Centralized Lubrication* No. 116

EIGHTEEN years ago, this continuous hot strip mill was installed at the Inland Steel Company, Indiana Harbor Works, East Chicago, Indiana. It was then the last word in rolling mills, with roll necks equipped with Timken bearings and lubricated with three Farval Heavy Duty Automatic Lubrication Systems.

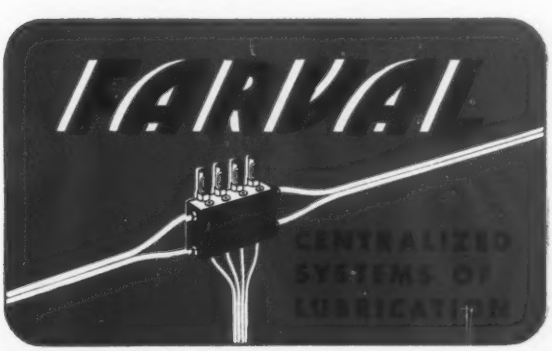
Since then this mill has rolled more than six million tons of steel. The Timken roll-neck bearing shown in this illustration, when removed for photographing, had a total of exactly 6,154,648 tons to its credit. Inspection at that time showed that the bearing was still in splendid condition, good for many thousand tons more. There has never been a bearing failure or an interruption of production because of inadequate lubrication—thanks to Farval.

Farval serves the vast majority of the world's hot strip mills—well over 70% of the mills in America and abroad. And since the original cold strip mill installations in 1930, more than 90% of all the continuous cold mills built have been equipped with Farval.

Farval is the original Dualine system of centralized lubrication that has proven itself through years of service. The Farval valve has only two moving parts—is simple, sure and fool-proof, without springs, ball-checks or pinhole ports to cause trouble. Through its full hydraulic operation, Farval unfailingly delivers grease or oil to each bearing—as much as you want, exactly measured—as often as desired. Indicators at every bearing show that each valve has functioned.

Write for Bulletin 25 for full details. The Farval Corporation, 3267 East 80th Street, Cleveland 4, O.

Affiliate of The Cleveland Worm & Gear Company, Industrial Worm Gearing. In Canada: Peacock Brothers Limited.



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